THE LINE OF PROPORTION OR NUMBERS, Commonly called *GUNTER's LINE*, MADE EASIE:

By which may be meaſured all manner of Superficies and Solids; as Board, Glaſs, Pavement, Timber, Stone, &c.

ALSO,

How to perform the ſame by a LINE of Equal Parts, drawn from the Centre of a *Two-Foot-Rule*.

Whereunto is added,

The Uſe of the Line of PROPORTION Improved: Whereby all manner of *Superficies* and *Solids*, may both exactly and ſpeedily be meaſured, without the help of Pen or Compaſſes, by Inſpection, looking only upon the *RULER*.

The **Eighth Edition** carefully Corrected, and other new Ways of Meaſuring added.

By *WILLIAM LEYBOURN*.

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1606/111.

TO THE

READER.

THIS Line *of* Proportion *or* Numbers, *commonly called (by Artificers)* Gunter'*s* Line, *hath been diſcourſed of by ſeveral Perſons, and variouſly applied to divers Uſes; For when Mr.* Gunter *had deduced it from the* Tables *of* Logarithms, *to a* Line, *and written ſome Uſes thereof, Mr.* Wingate *added divers other of the ſame Lines, variouſly diſpoſed, thereby to* Extract *the* Square *or* Cube Roots, *without doubling or trebling the diſtance of the Compaſſes. After him, Mr.* Milbourn, *a* Yorkſhire *Gentleman, diſpoſed it in a* Serpentine *or* Spiral Line, *thereby enlarging the Diviſion. Again, Mr.* William Oughtred *diſpoſed this Line in a Circle, as alſo the Lines (or*

Scales) *of Artificial* Sines *and* Tangents, *in other concentrick Circles with it; and writ the Uſes of them in Latin; which were afterwards Tranſlated into Engliſh, by Mr.* William Forſter, *and Printed under the Title of Mr.* Oughtred'*s* Circles of Proportion. *Alſo Mr.* Seth Partridge *contrived two Rulers, to ſlide one by the ſide of the other, having upon them two Lines of one length; which exactly and readily performeth all Operations wrought thereby, without the help of Compaſſes.*

Now whatſoever all the forementioned Contrivances will perform, I have here ſhewed in this Manual; and ſo ordered the Line, that it will perform the Work without Compaſſes, by Inſpection, looking only upon the Ruler. And thereby may be meaſured (let the Line be of what Length ſoever) not only Board, Glaſs, Timber, *and* Stone, *but alſo all manner of* Hangings, Pavements, Wainſcots, Plaiſtering, Tyling, Brick-work, *&c. To all which Uſes I have particularly ap-*

plied it, as will appear by ſeveral Examples in all the forementioned Particulars; and the rather, becauſe this Treatiſe may be beneficial and uſeful as well to Gentlemen and others, who may have occaſion to make uſe thereof, in Buying or Selling of Timber, *either ſtanding, or felled, and ſquared; as to Artificers themſelves, for whoſe Sakes chiefly it was intended.*

And therefore, in the firſt Part of this Treatiſe (after the Uſe of the Vulgar Carpenter's Rule) I have ſhewed the Uſe of the Line of Proportion, which Artificers commonly call Gunter's *Line, from the Name of the Man who firſt contrived it; (and as it is now generally put upon the Flat or Edge of all Carpenters Rules) firſt, in working of the ſeveral Rules of* Arithmetick, *as* Multiplication, Diviſion, *the* Extraction *of the* Square *and* Cube Roots; *and in the working of the* Golden Rule, *or* Rule of Proportion, *whereby the Menſuration of all*

Superficies *and* Solids; *as* Board, Glaſs, Pavements, *&c. and of* Solids, *as* Timber, Stone, *&c. and performed by the Rule and a Pair of Compaſſes: And afterwards by ſome of thoſe other Contrivances, I have before mentioned in this Preface to the Reader, and afterwards more at large in their due Places; to which and the reſt of this Manual I refer.*

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Vale.

How to Meaſure

BOARD and TIMBER

BY THE

Carpenter's Plain RULE.

ALL manner of Superficial and Solid Meaſures, may be meaſured the moſt abſolute and artificial ways that are yet known, by the Precepts and Examples in this Book delivered: But altho' every Capacity may not attain to the knowledge and underſtanding thereof, I thought good here to inſert the Uſe of that Rule, which is commonly made and ſold, and which every Artificer continually carries about him.

Its DESCRIPTION.

I. *Of the FORE-SIDE.*

It conſiſteth of two flat Sides, one of which, toward either edge thereof, is divided into 24 Equal Parts, called Inches, and numbered by 1, 2, 3, 4, and ſo on, to 24, at the end thereof. Every one of theſe Parts or Inches is again divided into two equal Parts, by Lines about half the length of the other, repreſenting half Inches; and every of thoſe half Inches is divided into two other equal Parts, called Quarters of Inches; and each of thoſe again into two other equal Parts, call'd Half-quarters of Inches: So that each Inch is divided into 8 equal Parts, repreſenting Inches, Halves, Quarters, and Half-quarters.

Both the Edges on the one ſide of the

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the Rule are thus divided and numbred, only where 24 ends at one end of the Line on one Edge, there 1 begins on the other Edge; ſo that, which end of the Rule ſoever you meaſure with, you may count your number of Inches and Parts right, without turning of the Rule.

II. *Of the BACK-SIDE.*

On the other ſide of the Rule you have two other Lines, or Scales, drawn near to the Edges of the ſame Side: One is called, *The Line of Board-meaſure*, the other, *The Line of Timber-meaſure*. At the beginning of either of theſe Lines you have a little Table in Figures, the one for *Board*, the other for *Timber* or *Stone*.

The Line or Scale of *Board-meaſure* begins at 6, towards your left hand, and ſo goes on to 36, ending juſt 4 Inches ſhort of the other end of the Rule; but ſometimes this Line is continued up to an hundred, but not often; and then it goes nearer to the end of the Rule, namely, to within an Inch and an half of the end thereof. At the beginning of this Line there is a ſmall Table, from 1 to 6 Inches, which ſhews (in Figures) the quantity of the length of a Foot of any Board, from 1 Inch broad to 6 Inches broad; and then the Diviſions ſupply the greater Breadths.

On the other Edge, on the ſame Side, you have the Line or Scale of *Timber Meaſure*. This Scale begins at 8 and an half, and ſo goes on (by Diviſions) to 36, towards the other end of the Rule, namely 36; ending within almoſt an Inch and an half of the Rule's end. To this Scale alſo there belongeth a *Table*, which ſtandeth at the beginning of the Line, and goes from 1 Inch, to 8 Inches, and gives the quantity of the length of a Foot of any *Timber* or *Stone*, under 8 Inches ſquare in Figures, as the other did for *Board*, from 1 to 6. And theſe are called, *The Tables of Under-Meaſure*.

The TABLE *for* *UNDER-BOARD-MEASURE.*

1	2	3	4	5	0
12	6	4	3	2	2
0	0	0	0	4	0

The TABLE *for* *UNDER-TIMBER-MEASURE.*

1	2	3	4	5	6	7	8
144	36	16	9	5	4	2	2
0	0	0	0	0	0	11	3

Thus much for the Deſcription of

the Lines upon the Carpenter's Plain Rule. Now for

Their USE.

I. *Of the Fore-ſide, or Side of Inches.*

This Side is only to meaſure the Length and Breadth of any thing to be meaſured in Inches and Parts; the manner of doing whereof is natural to every Man: For, taking the Rule in the left hand, apply it to the thing to be meaſured; ſo have you the Length, Breadth, or Thickneſs of the Thing deſired. But,

II. *Of the Back-ſide.*

AND,

I. *Of the Line of Board-meaſure.*

The Breadth *of any* Board *being given, to find how much thereof in* Length *will make a Foot ſquare.*

Look for the Number of Inches that your Board (or Glaſs) is broad, in the Line of *Board-meaſure*; and the Number of Inches and Parts of an Inch, which ſtand againſt that, on the other ſide of your Rule, is the quantity of Inches that will make a Foot ſquare of that Board, or Glaſs, or what other thing ſoever it be to be meaſured.

Example 1. *There is a Board or Plank that is 9 Inches broad, how much of that in length will make a Foot ſquare?*

Look for 9 Inches upon the Line of *Board-Meaſure* (which you ſhall find at the Figure 9, upon the ſame Line) and juſt againſt that, on the other ſide of your Rule, you ſhall find 16 Inches, which ſhews that every 16 Inches of that Piece in length, will make a Foot ſquare.

Example 2. *A Pane of Glaſs, is 22 Inches broad, How much thereof in length will make a Foot ſquare?*

Look for 22 Inches in the Line of *Board-Meaſure*, and right againſt it (on the other ſide of your Rule you) ſhall find 6 Inches, and almoſt an half; and ſo much in length of that breadth will make a Foot ſquare.

Example 3. *If any plain Superficies be 30 Inches broad, How much thereof in length will make a Foot ſquare?*

Seek for 30 Inches in the Line of *Board-Meaſure*, and right againſt it, on the other Side of the Rule, you ſhall find 4 Inches and $\frac{4}{5}$, that is, 4 Inches, and 4 fifth Parts of an Inch.

Example 4. *If a Board be 9 Inches and a half broad, How much thereof in length will make a Foot ſquare?*

Seek 9 Inches and an half, in the Line of *Board-Meaſure*, and againſt that on the other ſide of the Rule, you ſhall find 15 Inches, and about 1 ſixth part of an Inch, to make a Foot ſquare.

¶. *NOTE*. All theſe Examples might be performed otherwiſe by the Line; for if you take the Rule in your left-hand, and apply the end thereof, noted with 36, to the end of the Superficies to be meaſured; the other edge of the Superficies will ſhew how many Inches, Halves, and Quarters will make a Foot ſquare. This needs no Example.

PROBL. II.

The length and breadth of a Superficies being given, to find how many ſquare Feet are therein contained.

By any of the ways (before taught) find how much of the breadth given will make a Foot ſquare; then run that length from one of the ends of the Superficies as often as you can, and ſo many ſquare Feet are there in that Superficies.

Example. *A Board is 9 Inches broad, and 15 Foot long; How many ſquare Feet are therein contained?*

By the firſt Example you find that at 9 Inches broad, 16 Inches in length do make a Foot: Wherefore take 16 Inches of your Rule, and run that length along the Board from one end thereof, and you ſhall find that length to be contained in the Board of 15 Foot long, 11 times, and 4 Inches over, which is $\frac{1}{4}$ of a Foot; ſo that the Board of 15 foot long, and 9 Inches broad, contains 11 Foot and one Quarter. The like of any other.

II. *Of the Line of Timber meaſure.*

PROBL. I.

The Square of any Piece of Timber at the end thereof being given, to find how much of that Piece in length will make a Foot ſolid.

The Uſe of the Line of Timber-meaſure, is in all reſpects the ſame as that of Board-meaſure ; for knowing the ſquare of your Piece of Timber at the end thereof, you have no more to do than to look for the quantity of the Square thereof in the Line of Timber-meaſure, and right againſt it on the other ſide of the Rule, you have the quantity of Inches that will make a Foot ſolid of that Piece.

Example 1. *A Piece of Timber is* 10 *Inches ſquare, how much thereof in length will make a Foot ſolid?*

Look for 10 Inches in the Line of Timber-meaſure, and right againſt it on the other ſide of the Rule, you ſhall find 17 Inches and ſomewhat above a quarter of an Inch; and ſo much of that Piece in length will make a Foot ſolid.

Example 2. *If the Square of a Piece of Timber be* 21 *Inches, How much thereof in length will make a Foot ſolid ?*

Seek 21 Inches in the Line of Timber-Meaſure, and againſt it you ſhall find, on the other ſide of the Rule, almoſt 4 Inches; and ſo much in length will make a ſolid Foot of Timber.

Note 1. If Timber be broader at one end than at the other, the uſual way is to add both ends together, and take half thereof for the true Square: but if the difference be very much, this way is erroneous, though for the moſt part practiſed.

Note, 2. Alſo for round Timber, the uſual way is to girt it about the middle with a String, and take a fourth part thereof for the ſquare ; this alſo is erroneous : Therefore, for ſuch as deſire Curioſity and Exactneſs, let them repair to the Rules in this Book delivered for that Purpoſe, where they may receive ample Satisfaction.

Concerning the Tables at the beginning of the Lines of Board and Timber-meaſure.

The Table of Board-meaſure gives the length of a Foot ſquare of any Board under 6 Inches broad; therefore by the Table there ſet you may find that

	Inches broad	*Foot*	*In.*	*Parts.*	
If a Board be	1	12	0	0	will make a Foot ſquare.
	2	6	0	0	
	3	4	0	0	
	4	3	0	0	
	5	2	4	0	
	6	2	0	0	

By this ſmall Table you may ſee that a Board of 4. Inches broad, will require 3 Foot thereof in length to make a Foot ſquare,— Alſo, a Board of 5 Inches broad will require 2 Foot, 4 Inches, and 4 fifth parts of an Inch.

The Table of Timber-meaſure gives the length of a Foot ſolid, of any piece of Timber or Stone, whoſe ſquare is under 8 Inches : Wherefore, by the Table at the beginning of the Line of Timber-meaſure, you may find that

If a piece of Timber be	Inches Square,	Foot	In.	Parts.	will make a Foot ſolid.
	1	256	0	0	
	2	36	0	0	
	3	16	0	0	
	4	9	0	0	
	5	5	9	0	
	6	4	0	0	
	7	2	11	0	
	8	2	3	0	

By this Table (which is the ſame in effect with that which ſtandeth at the end of the Line of Timber-meaſure) you may ſee that a piece of Timber that is 4 Inches ſquare, requires 9 Foot in length to make a ſolid Foot: Alſo a piece of 5 Inches ſquare, requires 5 Foot, 9 Inches, and $\frac{1}{10}$ part of an Inch, to make a Foot ſolid. And ſo of the reſt.

But becauſe theſe Tables go only to whole Inches, I have here added two Tables, one for Board, the other for Timber; the Table for Board, from one quarter of an Inch to 6 Inches in breadth; and the Table for Timber, from two Inches ſquare to 8 Inches, by Inches, Halves, and Quarters.

The TABLES *follow.*

The

The TABLE *for Board-meaſure.*

In.&q.		*feet*	*in.*	10 *p.*	*In.&q.*		*feet*	*in.*	10 *p.*
	1	48	0	0	III.	0	4	0	0
	2	24	0	0		1	3	8	3
	3	16	0	0		2	3	5	1
I.	0	12	0	0		3	3	2	4
	1	9	7	2	IV.	0	3	0	0
	2	8	0	0		1	2	9	9
	3	6	10	2		2	2	8	0
II.	0	6	0	0		3	2	6	3
	1	5	4	0	V.	0	2	4	8
	2	4	9	6		1	2	3	4
	3	4	4	4		2	2	2	3
III.	0	4	0	0		3	2	1	0

The TABLE *for Timber-meaſure.*

II.	0	36	0	0	V.	0	5	9	1
	1	28	4	3		1	5	2	7
	2	23	0	4		2	4	9	1
	3	19	0	3		3	4	4	2
III.	0	16	0	0	VI.	0	4	0	0
	1	13	7	6		1	3	4	2
	2	11	9	1		2	3	4	9
	3	10	1	8		3	3	1	9
IV.	0	9	0	0	VII.	0	2	11	2
	1	7	11	6		1	2	8	1
	2	7	1	3		2	2	6	7
	3	6	4	6		3	2	5	7

The AUTHOR's *Advertiſement.*

IF any Gentleman, or other Perſon deſire to be inſtructed in any of the Sciences Mathematical, as *Arithmetick*, *Geometry*, *Aſtronomy*, the Uſe of the *Globes*, *Trigonometry*, *Navigation*, *Surveying of Land*, *Dialling*, or the like; The Author will be ready to attend them at Times appointed.

Alſo if any Perſon would have his Land, or any Ground for Building *Surveyed*, or any Edifice or Building, *meaſured*, either for the *Carpenters*, *Brick-layers*, *Plaiſterers*, *Glaſiers*, *Joiners*, or *Maſons* Work, he is ready to perform the ſame, either for *Maſter-Builder* or *Workman.*

Likewiſe if any Perſon deſire to have about his Houſe or Garden any kind of Sun-Dial, or Dials, of what kind ſoever, either fix'd or moveable, he will prepare or make for them ſuch as they ſhall deſire.

You may hear of him where theſe Books are to be ſold.

THE LINE OF Proportion, or Numbers; Commonly called GUNTER's LINE, MADE EASIE.

WHAT this Line is, and how to make it, is beſt known to thoſe who make *Mathematical Inſtruments*; but the Uſes of it are ſo general, that all Sorts of Men of what Faculty ſoever, may apply it to their particular Uſes; tho' it more immediately and particularly concerns ſuch Artificers whoſe Employment conſiſts in *Menſuration* : As *Carpenters*, *Joyners*, *Maſons*, *Bricklayers*, *Painters*, *Glaſiers*, and ſuch like ; for that all kind of Menſurations, either *SUPERFICIAL*, as *Board*, *Glaſs*, *Pavement*, *Tyling*, &c. or *SOLID*, *as Timber*, *Stone*, *Columns*, *Pyramids*, &c. are by this Line moſt eaſily, ſpeedily and exactly perform'd: For whatſoever thing, concerning Meaſure, that may be performed by *Arithmetick*, this Line will do exactly, and much ſooner ; as by the working of the ſeveral *Rules* in *Arithmetick*, by this Line, ſhall be plainly made appear.

CHAP. I.

NUMERATION upon the Line.

BEfore I ſhew you how to number upon the Line, it will be neceſſary to let you underſtand how the

Line is divided and numbered, as alſo what thoſe Diviſions and Numbers ſet to them upon the Ruler, do ſignify.

Know therefore, that the Line of Numbers begins at the Figure One, and ſo proceeds ſucceſſively from 1 to 2, 3, 4, 5, 6, 7, 8, 9, to 10 (or 1 in the middle of the Line; and then on farther, by 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, at the end of the Line.

The firſt 1, which ſtandeth at the beginning of the Line, repreſenteth the *one tenth part* of any Unit or Integer, as *one tenth* part of a *Foot*, *one tenth* part of a *Yard*, *Ell*, *Perch*, *Mile*, &c. Or it may ſignify *one tenth* of a *Year*, *Month*, *Hour*, &c. Or the *one tenth* of a *Pound*, *Shilling*, or *Penny*, &c. Or the *one tenth* part of any thing, either in *Number*, *Weight*, *Meaſure*, *Time*, or the like. The Figure 2, ſignifies *two tenth Parts* of any thing : The Figure 3, *three enth parts* : The Figure 4, *four tenth arts*, &c. till you come to the ſecond

1, which ſtandeth in the middle of the Line; which one ſignifieth *One whole Unit* or *Integer*, as one whole *Foot*, *Yard*, *Perch*, &c.

Now the other intermediate Diviſions, thoſe which ſtand between the Figures 1 and 2 (which are in number ten) do repreſent (each of them) one hundredth part of one Unit, or Integer; ſo the firſt Diviſion beyond the Figure 1, repreſents 1 hundred Parts of the Integer; the ſecond Diviſion, 11 hundred parts of the Integer; and ſo on: The Figure 2 repreſenting 20 hundred parts of the Integer; and the next Diviſion beyond 2, is 21 hundred Parts, and ſo on, till you come to the Figure 1 in the middle of the Line, which repreſenteth one whole Integer. The Figure 2 ſignifieth *two whole Integers*, ; the Figure 3, *three whole Integers*, and ſo on till you come to 10 at the end of the Line, which ſignifieth *Ten whole Integers* ; and the intermediate Diviſions, which ſtand be-

between 1 and 2 in the middle of the line, are (every of them) *tenth parts* of the Integer. So the Rule contains *Ten whole Integers*, every of which is divided into ten Parts.

But if upon the Line you would count Numbers of more places than two (which are all Numbers above 10) then the 1 which is at the beginning of the line, muſt be accounted *one Integer*; and the 1 in the middle of the line, *ten Integers*; and the 10 at the end, will be 100 *Integers*.

But yet farther, if upon the line you would expreſs Numbers of more places than *Three* (which are all Numbers above 100) then the 1 at the beginning of the line is to be accounted *ten Integers*, the 1 in the middle *One hundred Integers*; and the 10 at the end of the line, *One thouſand Integers*, &c.

And if you proceed yet farther; then the 1, at the beginning, muſt be accounted for *one hundred Integers*;

that in the middle, *one thouſand*; and the 10 at the end of the Line, for *Ten thouſand Integers.*

In this manner you may proceed farther, by counting the firſt 1 for 1000, 10000, *&c.* Integers; but to four Places is ſufficient; which by a Rule of a competent length (as of two Foot) any Queſtion concerning Meaſuring, may be exactly enough perform'd.

The Diviſions and Numbers on the Line being thus explained, it reſteth now to ſhew you how to find that Point upon the Line, which ſhall repreſent any Number propoſed: and that I ſhall ſhew you in theſe *Propoſitions* following, which may fitly be called, *NUMERATION.*

PROP. I.

A whole Number *conſiſting of Two, Three, or Four Places, being given; to the* Point *upon the* Line *which repreſenteth the ſame.*

NOTE, let your Number given be of how many places ſoever; for the *Firſt* Figure of your Number, you muſt take the ſame Figure upon the Line: For the *Second* Figure in your Number, take the Number thereof on the grand (or larger) intermediate Diviſions on the Line. For the *Third* Figure in your Number, take the Number thereof on the ſmaller intermediate Diviſions on the Line. And for your *Fourth* Figure, you muſt find its place by eſtimation; by ſuppoſing the ſpace or diſtance of the intermediate Diviſion to be divided into 10 parts, according to the nature of the Line.

Example I. *Let it be required to find the Place of* 15 *upon the Line.*

For your firſt Figure 1, count the 1, in the middle of the Line: then for the 5, which is your ſecond Figure, count five of the grand (or larger) intermediate Diviſions upon the Line, and that Point is the very place upon the Line repreſenting 15.

Again, *To find the place upon the Line repreſenting* 37. For your firſt Figure, 3, count the Figure 3, which ſtands between the 1 in the middle, and 10 at the end, upon the Line; then for the 7, count 7 of the intermediate Diviſions, and that Point is the place upon the Rule repreſenting 37.

Note, That every fifth of the grand intermediate Diviſions is drawn forth with a longer Line than the reſt, for eaſe in counting.

Example II. *Let it be required to find the place of* 134 *upon the Line.*

For your firſt figure 1, count the 1, in the middle of the Line; for your ſecond Figure 3, count three of the grand Diviſions; and for the third Figure 4, count 4 of the ſmalleſt intermediate Diviſions, and that very point is the place upon the Line repreſenting 134.

Again, *To find the place repreſenting* 308. For your firſt Figure 3, count the three which ſtands between the middle 1 and 10 upon the Line: For your ſecond Figure 0 (which is a Cypher) count none of the grand Diviſions; but for your laſt Figure 8, imagine the firſt grand Diviſion following the figure 3, to be divided into 10 parts, and imagine 8 of 'em in your mind; and that Point ſhall be the place upon the line repreſenting 308.

Example III. *Let it be required to find the place of* 1350.

For your firſt Figure 1, take 1 on the middle of the Line: For your ſecond Figure 3, take the Figure 3 upon the Line upwards: for the 5, count five of the grand intermediate Diviſions;

ſions; and that is the place of 1350.

Again, *To find the place of* 1626: For your firſt Figure 1, count the 1 on the middle of the Line: For your ſecond Figure 6, count the Figure 6 upon the Line upwards: then for your third Figure 2, count two of the grand Diviſions; and for your laſt Figure 6, eſtimate ſix tenth parts of the next grand Diviſion (which is ſomething more than half the Diſtance, becauſe 6 is more than half 10,) and that is the Point upon the Line repreſenting 1626.

Note, By theſe Examples laſt mentioned, you may perceive, that the Figures 1, 2, 3, 4, 5, 6, 7, 8, 9, do ſometimes ſignifie themſelves alone, ſometimes 10,20,30, *&c.* ſometimes 100, 200, 300, *&c.* as the Work performed thereby ſhall require. The firſt Figure of every Number is always that which is here ſet down, and the reſt of the Figures are to be ſupplied according as the nature of the *Queſtion* ſhall require.

And by this variation and change of the *Powers* of theſe *Numbers* from 1 to 10, or 100, or 1000, any Proportion, either *Arithmetical* or *Geometrical*, may be wrought. One whereof I will inſert, for your better exerciſe of numbering on the *Line*; by the often practice thereof, you will find the WORK facile and delightful; which ſhall be this following.

PROP. II.

Having two Numbers given to find as many more as you pleaſe, which ſhall be in Continual Proportion *one to another, as the two Numbers given were.*

FOR the working of this Propoſition, this is THE RULE: *Place one Foot of the Compaſſes in the firſt given Number on the Line, and extend the other Foot to the ſecond given Number; then may you turn the Compaſſes*

paſſes from that ſecond Number to a third, from that third to a fourth; from that fourth to a fifth, a ſixth, a ſeventh, &c. to what Number of Places you pleaſe.

Example I. *Let the two given Numbers be* 2 *and* 4.

Place one Foot of your Compaſſes in 2, at the beginning of the Line, and extend the other Foot to 4; then that Foot which now ſtandeth in 2, being turned about, will reach from 4 to 8, and from 8 to 16, from 16 to 32, from 32 to 64, from 64 to 128.

But when your Compaſſes ſtand in 64; if you turn them about yet farther, they will fall beyond the end of the Line; wherefore you muſt place one Foot in ſome other 64, nearer the beginning of the Line, and then the other Foot will reach to 128, and from 128 to 256, and from 256 to 512, and from 512 to 1024: But here it will go off of your Line again, wherefore (as before) you muſt chuſe another 512 nearer the beginning of the Line ; and there placing your Compaſſes, they will reach to 1024, from 1024 to 2048, from 2048 to 4096, &c.

Example II. *But if the given Number were* 10, *and* 9 Decreaſing ;

Then place one Foot in 10 at the end of the Line, and extend the other downwards to 9 ; the ſame extent will reach ſtill downwards to 8.1 (for $8\frac{1}{2}$.) and from 8.1 to 7.29, and ſtill downwards from 7.29 to 6.59.

Likewiſe, if the two firſt Numbers had been as 1 to 9, the third Proportional would have been 81, the fourth 729, and the fifth 656, with the ſame extent of the Compaſſes.

Again, *Let the two Numbers be* 10 *and* 12 : Place one Foot in 10, and extend the other to 12, that extent will reach from 12 to 144, and from thence to 17.28.

But if the Numbers were 1 and 12, then the third Proportional would be 144, and the fourth 1720, and all with the ſame extent of the Compaſſes.

CHAP. II.

MULTIPLICATION *by the* LINE.

IN Multiplication, the Proportion is this: As 1 upon the Line,

Is to one of the Numbers to be multiplied:

So is the other of the Numbers to be multiplied,

To the Product of them, which is the Number ſought:

Example I. *Let it be required to multiply 5 by 7.*

The Proportion is;

As 1 : Is to 5 : : So is 7 : To 35.

Therefore, Set one Foot of your Compaſſes in 1, and extend the other Foot to 5; with that extent of the Compaſſes place one Foot in 7, and the other Foot will fall upon 35, which is the Product.

Example II. *Let it be required to multiply 32 by 9.*

The Proportion is;

As 1 : To 9 :: So 32 : To 280.

Set one Foot in 1, and extend the other Foot to 9; that ſame extent will reach from 32 to 281, which is the Product or Sum of 32, being multiplied by 9. Otherwiſe,

Set one Foot in 1, and extend the other to 32; the ſame extent will reach from 9 to 288, as before.

Example III. *Let it be required to multiply* $8\frac{75}{100}$ *by* $6\frac{45}{100}$.

The Analogy or Proportion is,

As 1 : To 8.75 :: So 6.45 : to 56.44 *feré*.

Set one Foot in 1, and extend the other to 8.75; the ſame extent applied forward upon the Line will reach from 6.45, to 56.44 *feré*.

Or if you ſet one Foot in 1, and extend the other to 6.45: the ſame extent will reach from 8.75 to 56.44 almoſt (namely, to $43\frac{3}{4}$) as before.

CHAP. III.

DIVISION by the Line.

IN Diviſion three Things are to minded, *viz.*

The
- *Dividend*, or Number to be divided.
- *Diviſor*, the Number by which the Dividend is divided.
- *Quotient*, which is the Number ſought.

And, as often as the Diviſor is contained in the *Dividend*, ſo often doth the *Quotient* contain *Unity*.

For the working of Diviſion, this is the Analogy, or Proportion.

As the *Diviſor,*
is to *Unity*, or 1,
So is the *Dividend,*
to the *Quotient.*

Example I. *Let it be required to Divide 35 by 7.*

The Proportion is,

As 7 : to 1 : : ſo 35 : to 5.

Set one Foot of the Compaſſes in 7, and extend the other Foot downwards to 1; that ſame extent will reach from 35 downwards to 5, which is the Quotient; and ſo many times is 7 contained in 35.

Otherwiſe, extend the Compaſſes upwards from 7 to 35; that ſame extent will reach upwards from 1 to 5, as before.

Example II. *Let it be required to divide 288 by 32.*

The Proportion is,

As 32 : to 1 : : ſo 288 : to 9.

Extend the Compaſſes downwards from 32 to 1, the ſame extent will reach downwards from 288 to 9, which is the Quotient.

Or extend the Compaſſes upwards from 32 to 288 ; the ſame extent will reach upwards from 1 to 9, as before.

Example III. *Let it be required to divide 56.34 by 8.75.*

The Proportion is,

As 8.75 : to 1 : : ſo 55.44 : to 6.45.

Extend the Compaſſes downwards from 8.75 to 1 ; the ſame extent will reach downwards from 56.44 to 6.45.

Or, extend them upwards from 8.75, to 56.44 ; the ſame will reach upwards from 1 to 6.45, as before.

Note this in *Diviſion*, That ſo many times as the *Diviſor* may be orderly ſet under the *Dividend* in *Arithmetical*

tical Work, ſo many Places of *Figures* ſhall be in the *Quotient* of your *Diviſion* : As if 34785 were to be divided by 75, the *Quotient* ſhall conſiſt of Three Figures only, namely of 463, becauſe 75 can be but three times ſet orderly under 34785, in *Arithmetical* Operation.

CHAP. IV.

The GOLDEN RULE *Direct by the Line.*

THis Rule may well be termed the *Golden Rule*, it being the moſt uſeful of all others; For having three Numbers given, you may, by it, find a fourth in proportion to them; as by divers *Examples* following ſhall be made plain. And this *Rule* is performed upon the *Line*, with the like Eaſe and Exactneſs, as any of thoſe before mentioned : And for the working of it upon the Line, this is the general *ANA-*

ANALOGY or *PROPORTION*.

As the *Firſt Number* given,
Is to the *Second Number* given:
So is the *Third Number* given,
To the *Fourth Number* required.
Or,
As the *Firſt Number* given,
Is to the *Third Number* given:
So is the *Second Number* given,
To the *Fourth Number* ſought.
Wherefore

GENERAL RULES.

Always, *Extend the* Compaſſes *from the* Firſt Number *to the* Second, *and that* Diſtance, *or* Extent, *applied the ſame way upon the* Line, *ſhall reach from the* Third, *to the* Fourth Number *required.*

Or, otherwiſe, *Extend the* Compaſſes *from the* Firſt Number *to the* Third, *and that Extent applied the ſame way, ſhall alſo reach from the* Second *to the* Fourth.

Either of theſe ways will effect the ſame things, as by *Examples* following ſhall be made appear.

And it is neceſſary thus to vary the *Proportion*, ſometimes to avoid the opening of the Compaſſes too wide: For when the Compaſſes are opened to a very large extent, you can neither take off any Diſtance exactly, nor give ſo good an Eſtimate of any parts required, as you may do when they are opened to a leſſer Diſtance: But this you will find out beſt by Practice; and therefore I will now proceed to Examples.

Example 1. *If* 45 *Yards of Cloth coſt* 30 l. *what will* 84 *Yards coſt at the ſame rate?*

As 45: to 30:: ſo 84: to 56.

Extend the Compaſſes from 45, downward to 30, that extent will reach downward from 84 to 56 *l.* the Price of 84 Yards.

Or, extend the Compaſſes upwards from 45 to 84, the ſame will reach from 30 to 56, as before.

Example 2. *If* 26 *Acres of Land be, worth* 64 l. *a Year; what are* 36 *Acres of the like Land worth by the Year?*

As 26 : to 64 : : ſo 36 : to 88.615.

Extend the Compaſſes from 26 to 64, the ſame extent will reach from 36 to 18 $\frac{615}{1000}$ Parts (which is about 12 *s.* 3 *d.* 2 *q.*) and ſo much are 36 Acres of the like Land worth by the Year.

Example 3. *If* 100 l. *yield* 6 l. *Intereſt for one Year, or* 12 *Months, what ſhall* 75 l. *yield?*

As 100 : to 6 : : ſo 75 : to 4.50.

Extend the Compaſſes from 100 to 6, the ſame extent will reach from 75 to 4.50 (or 4$\frac{1}{2}$) which is 4 *l.* 10 *s.* and ſo much will 75 *l.* yield Intereſt in the Year.

Example 4. *If* 75 l. *yield* 4 l. 10 *s. Intereſt for one year,* or 12 *months, what will* 100 l. *yield?*

As 75 : to 4.50 : : ſo 100 : to 6.

Extend the Compaſſes downwards from 75 to 4.50, the ſame extent will reach

each from 100 to 6; and ſuch Intereſt will 100 *l.* yield.

Many other *Queſtions* might be added; but the *Rule* (and manner of working it) is ſo *plain*, that it needs them not; and ſo *general*, that he which can reſolve one, may as well reſolve another: and therefore I ſhall ſay no more of it in this Place.

CHAP. V.

The GOLDEN-RULE *Reverſe by the* LINE.

IN this *Reverſe* or *backward Rule* of *Three*, this Note is eſpecially o be obſerved, That if the *Third Number* be *Greater* than the *Firſt*, hen will the *Fourth Number* be *Leſs* han the *Second*. And on the contrary; If the *Third Number* be *Leſs* han the *Firſt*, then the *Fourth* Number will be *greater* than the *ſecond*: As by *Examples* will appear.

Example 1. *If* 12 *Workmen, do any Piece of Work in* 8 *Days, how many Workmen ſhall do the ſame Piece of Work in* 2 *Days?*

It is here to be noted, That in this *Queſtion*, 12 is not the firſt Number (though it be firſt named) but 2; for the middlemoſt Term of the three muſt be of the ſame kind with the fourth Number which is to be ſought; as in this *Example* it is *Men*, therefore 12 (which are *men*) muſt ſtand in the *middle*, or *ſecond place*, becauſe the *fourth Number*, which is to be ſought, is alſo *Men*: And therefore the Numbers ſtand thus;

days.	men.	days.
2	12	8

For if 8 days require 12 Men, then 2 days (which is but a fourth part of 8 days) ſhall require four times 12 Men, that is 48 Men.

For here, *Leſs* requires *More*; that is, *Leſs Time*, *More Hands*: and hence the Work is contrary to the *Direct Rule*. Wherefore to effect it, this is

The RULE.

Extend the Compaſſes from the Third Term, *to the* Firſt : *The ſame Extent will reach (being turned the contrary way) from the* Second Term *to the* Fourth :

Or, *The extent from the* Firſt Term *to the* Third, *will reach (the ſame way) from the* Second *to the* Fourth :

As in this Example.

Extend the Compaſſes from 8 downwards to 2, the ſame extent will reach from 12 (the contrary way on the Line) to 48, which is the Number of Men that will effect the ſame Piece of Work in two Days.

Or, Extend the Compaſſes from to 8, the ſame extent will reach (the ſame way) from 12 to 48, a before.

Example 2. *If 1 Cloſe will graze 2 Horſes for 6 Weeks, how many Horſes will the ſame Cloſe graze for Weeks?*

Extend the Compaſſes from 6 t 7; for you muſt always extend you Compaſſes to Numbers of one kin or denomination : as here 6 and are both Horſes, the ſame Exte will reach from 21 backward to 18 and ſo many Horſes will the ſam Cloſe graze for 7 Weeks.

CHAP. VI.

Of DUPLICATE PROPORTIO by the Line.

D*Uplicate Proportion* is ſuch a Pr portion as is betwen *Lines* an *Superficies*, or between *Superficies* an *Lines*.

I. C

I. *Of the Proportion of* LINES *to* SUPERFICIES.

The RULE.

Extend the Compaſſes from the Firſt, *to the* Second Number *of the ſame* Denomination; *that ſame extent (being doubled) ſhall give the diſtance from the* Third Number *unto the* Fourth.

Example 1. *If the* Diameter *of a* Circle *be* 14 *Inches, and the* Area *or Content thereof be* 154 *Inches; what will be the Content of another* Circle, *whoſe* Diameter *is* 28 *Inches?*

Extend the Compaſſes from 14 to 28; that extent doubled, will reach from 154 to 616: For firſt it will reach from 154 to 308, and from thence to 616; and that is the *Area* or *Content* of a *Circle* whoſe *Diameter* is 28.

Example 2. *If a Piece of Land that i 20 Pole ſquare, be worth* 30 l. *wha is a piece of Land of the ſame Goodneſs worth, that is 35 Pole ſquare?*

Extend the Compaſſes from 20 t 35; that extent doubled will reac from 30 to 91.8, that is, 91 *l.* $\frac{8}{10}$ o a Pound, which is 16 *s.* and ſo muc is ſuch a piece of Land worth.

II. *Of the Proportion of* SUPERFICIE *to* LINES.

The RULE.

Extend the Compaſſes unto the half the diſtance between the two Numbers the ſame Denomination; that ſame extent ſhall reach from the Third Number *to the* Fourth *required.*

Example 1. *Let there be two Circles gi ven, the Area or Content of the one b ing 154, and its Diameter 14: Th Area of the other Circle is 616; wh is the length of its Diameter?*

Upo

Upon your Line divide the diſtance between 154 and 616 into two equal parts; then with that diſtance ſet one Foot in 14, and the other ſhall fall upon 28, which is the length of the Diameter of the other Circle, whoſe Area is 616.

Example 2. *There is piece of Land containing* 20 *Pole ſquare worth* 30l. *there is another piece worth* 91 l. 16 s. *how many Pole ſquare ought that piece to contain?*

Take with your Compaſſes half the diſtance between 30 *l.* and 91 *l.* 16 *s.* then ſet 1 Foot in 20 Pole and the other Foot will reach to 35 Pole; and ſo many Pole ſquare muſt the Land be that is worth 91 *l.* 16 *s.*

CHAP. VII.

Of TRIPLICATE PROPORTION, by the Line.

TRiplicate Proportion *is ſuch* Proportion *as is between* Lines *and* Solids, *or between* Solids *and* Lines.

Of the Proportion between LINES *and* SOLIDS.

The RULE.

Extend the Compaſſes from the Firſt Number to the Second of the ſame Denomination; that extent (being tripled) ſhall reach from the Third Number to the Fourth.

Example. *There is a Bullet whoſe Diameter is* 4 *Inches, weighing* 9 ℔. *what ſhall another Bullet of the ſame Metal weigh, whoſe Diameter ſhall be* 8 *Inches?*

Extend the Compaſſes from 4 to 8 (the two *Diameters*) the ſame extent (being tripled will reach from 9 to 72, which is the weight of a *Bullet* whoſe Diameter is 8 Inches.

II. *Of the Proportion of* SOLIDS *to* LINES.

The RULE.

Extend the Compaſſes unto the third Part of the diſtance between the two Numbers *of like* Denomination *; that ſame extent ſhall reach from the* Third *to the* Fourth Number *required.*

Example. *The weight of a Cube being 72 pound, the Side whereof was 8 Inches ; and the weight of another Cube of the ſame matter weighing nine pound, what muſt the Side be ?*

Upon your Line divide the diſtance between 9 and 72 into three equal parts ; then ſet one Foot of that diſtance in 8, and the other Foot ſhall reſt in 4, the length of the Side of the Cube required.

CHAP. VIII.

The Extraction of the S*QUARE* *ROOT by the Line.*

TO extract the *Square-Root*, is to find a *Mean Proportional Number* between 1 and the Number given; and therefore is to be found by dividing the Space between them into two equal Parts.

Example. *Let it be required to find the ſquare-Root of* 36.

Extend the Compaſſes from 1 to 36, the middle way upon the Line between theſe two Numbers is 6, which is the Square-Root of 36. In like manner you may find the Square-Root of 81 to be 9, of 144 to be 12, of 256 to be 16; and of other Numbers, as in this Table.

Root

Root.	*Square.*	*Root.*	*Square.*
1	1	11	121
2	4	12	144
3	9	13	169
4	16	14	196
5	25	15	225
6	36	16	256
7	49	17	289
8	64	18	324
9	81	19	361
10	100	20	400

If you ſuppoſe the Number to have Pricks over every ſecond Figure, as is uſual in the *Arithmetical Operation*, then if the laſt Prick towards the left hand fall over the laſt Figure (which will always be when the number of Figures are *Odd*) then it will be beſt to place Unity at the 1 in the middle of the Line, ſo that the *Root* and the *Square* may both fall forwards towards 10 at the end of the Line.

But if the Number of Figures be *Even*, it will then be beſt to place Unity at 10 at the end of the Line; ſo the *Root* and the *Square* both will fall backwards towards the middle of the Line.

CHAP. IX.

The Extraction of the CUBE-ROOT, by the Line.

TO extract the *Cube-Root*, is to find the firſt of two mean Proportionals between 1 and the Number whoſe *Cube-Root* you require; and is therefore to be found upon the Line, by dividing the ſpace between them into three equal Parts.

Example. *Let it be required to find the Cube-Root of* 216.

Extend the Compaſſes from 1 to 216, one third part of that diſtance ſhall reach from 1 to 6, which is the

Cube-Root of 216. In like manner you may find the *Cube-Root* of 729 to be 9, of 1728 to be 12, of 110592 to be 48, of 493039 to be 79, *&c.* as in this TABLE.

Root.	*Cube.*	*Root.*	*Cube.*
1	1	11	1331
2	8	12	1721
3	27	13	2197
4	64	14	2744
5	125	15	3375
6	216	16	4096
7	343	17	4913
8	512	18	5832
9	729	19	6859
10	1000	20	8000

Now becauſe it is troubleſome in the *Square-Root* to divide the ſpace into two, and in the *Cube-Root* into three equal Parts, you may (if you have often Occaſion for this Work) have on your Rule other Lines of Numbers; as one twice, and another thrice ſo long as the other; and then this Work may be wrought upon the

Lines, without dividing the diſtance upon the Line.

CHAP. X.

The Uſe of the LINE *applied to* Superficial-Meaſure, *ſuch as Board, Glaſs, Wainſcot, Pavement, Hangings, Painting,* &c. *of what kind ſoever.*

THE *Meaſures* by which *Board, Glaſs, Timber, Stone,* and ſuch like, are meaſured, is by the *Foot,* a Foot containing 12 *Inches* ; and each Inch into eight Parts, called *Halves, Quarters,* and *Half-quarters* : But this kind of Diviſion not being conſentaneous or agreeable to the Diviſions upon your Line of *Proportion* ; where between 1 and 2 is divided (not into 8, but) into 10 Parts, the like between 2 and 3 into 10 Parts, and ſo between 3 and 4 4 and 5, *&c.* Therefore I hold it requiſite, both for eaſe and exactneſs, to have every Inch on your Two-foot Rule divided, not into 8, but into 10 equal Parts, which hereafter (throughout this Book) we will call *Inch-meaſure.*

Again, Whereas your *Foot* is divided into 12 equal parts, call'd *Inches,* I would have your *Foot* divided into 10 equal parts, and each of thoſe parts ſubdivided into 10 other equal parts, ſo will your whole *Foot* contain 100 equal parts, which will be agreeable to the Diviſions of your *Line,* and facilitate the Work, as by the *Examples* in this kind given will be made to appear; and this we ſhall hereafter call *Foot-meaſure.*

But if any Perſon be ſo wedded to *Inches, Halves,* and *Quarters,* that he will not be beaten out of his Opinion, but perſiſt therein, and yet is deſirous to have knowledge in the Uſe of this Line; I ſay, ſuch Perſon may have added to the ſide of his Inches, Halves, and Quarters (by way of Facing, as I term it) a Line of *Foot-meaſure*, and alſo his Inches into 10 as well as 8, ſo that he may meaſure by one, and work upon his Line by the other. And this indeed will be neceſſary to be done, upon the Rules of thoſe ingenious Artificers who need them not; for that they many times meet with wilful Perſons, that will have them to meaſure their way, how diſconſentaneous to Reaſon ſoever it be.

In this nature would I have the Rule divided; and in this manner have I cauſed them to be made, both for my ſelf and others: And a Figure of Foot an Inch meaſure I have inſerted towards the beginning of the Book.

And here note, that what is here ſaid concerning dividing the *Inch* and *Foot* into 10 Parts, the like is to be underſtood of the *Yard*, *Ell*, *Pole* or *Perch*, or any other *Meaſure* whatſoever.

Theſe things being premiſed, we will now proceed to Examples.

I. *Examples in Inch-meaſure only.*

Example 1. *Let a Board or Plank be 27 Inches broad, and 263 Inches long; how many ſquare Inches is there in ſuch a Plank?* The Proportion is,

As 1, is to 27, the breadth in Inches:

So is 263, the length in Inches,

To 7101, the number of ſquare Inches in the whole Plank.

Extend the Compaſſes from 1 to 27; the ſame extent, forwards, will reach from 263, to 7101, the Content.

Or, you may extend the Compaſſes from 1 to 263, the ſame will reach from 27 to 7101, as before.

Example 2. *Let a Pane of Glaſs be* 53.4. *Inches broad, and* 126.8 *Inches long; how many Foot is there in that Pane?*

The Proportion is,

As 144 (becauſe 144 Inches make 1 Foot)
Is to 53.4, the breadth in Inches:
So is 126.8, the length in Inches,
To 47.06, the Content in Feet.

Extend the Compaſſes from 144 downwards to 53.4; the ſame will reach (the ſame way) from 126.8, to 47.06, which is 47 Foot, and $\frac{006}{100}$ parts of a Foot, the Contents of the whole Pane.

Example 3. *If a Marble Foot-pace or Walk be* 20 *Inches broad, how much in length of that will make a Foot ſquare?*

The Proportion is,

As 20, the breadth in Inches,
is to 144, the Inches in one Foot:
So is 1 Foot unto the length of one Foot in Inch-meaſure.

Extend the Compaſſes from 20 to 144; that extent will reach the ſame way from 1 to 7.2: ſo that 7 Inches and $\frac{2}{10}$ of that breadth will make a Foot ſquare.

II.

II. *Example in Foot-meaſure only.*

Example 1. *Let a Floor or Stone-pavement be 52 Foot broad, and 1105 Foot long, how many foot ſquare is that Floor or Pavement?*

The Proportion is,

As 1 Foot,
to 52 Foot the breadth:
So 100.5 Foot the length,
to 5746 the Content in ſquare Feet.

Extend the Compaſſes from 1 to 52, the ſame will reach from 110.5, to 5746, the content of the Pavement or Floor in ſquare Feet.

Example 2. *There is a Plank of Cedar 2 Foot 25 parts broad; how much in length thereof will make a Foot ſquare?* The Proportion is,

As 2.25 the breadth,
is to 1:
So is 1, or any number of Feet,
to the length of a Foot-ſquare in Foot-meaſure.

Extend the Compaſſes from 2.25 to 1; that extent will reach back from 100, which is one Foot, to 44 parts; and ſo many parts in length of that Plank will make a Foot. In like manner 88 parts will make 2 Foot, 1 Foot 32 parts will make 3 Foot, *&c.* For,

As 2.25 is to 1 Foot:

$$\text{So is} \left\{\begin{array}{c}100\\200\\300\end{array}\right\} \text{Parts, to} \left\{\begin{array}{c}44\\88\\132\end{array}\right\} \text{Parts.}$$

III. *Examples in* Inch-Meaſure *and* Foot-meaſure *together.*

Example 1. *Let a* Board *be 30 Inches broad; and 15 Foot and* ½ *or 25 parts long; how many Foot ſquare doth ſuch a Board or Plank contain?*

The Analogy is,

As 12 Inches,
to 30 the breadth in Inches:
So 15.25, the length in Feet,
to 38.125, the content in Feet.

Extend the Compaſſes from 12 to 30, the ſame will reach from 15.25

to 38.125; and ſo many Foot ſquare is contained in ſuch a Plank.

I will conclude this Chapter with this uſeful and neceſſary *Problem*: Namely;

By having the length and breadth of any long Square, or Parallelogram given; to find the length of the Side of a Geometrical Square equal thereunto.

This by the Line is eaſily effected; for if you take the half-diſtance upon your Line between the length and the breadth, the Number upon which the Compaſs point reſteth ſhall be the length of the Side of the Geometrical Square equal to the long Square, or Parallelogram.

Note, By a long Square or Parallelogram is meant any Square, whoſe Sides are longer than one another, as any long Table, &c. *But a Geometrical Square is that whoſe* 4 *ſides are all of one length and the Angles all ſquare or right Angles.*

Example. Let the longer Side of a Parallelogram be 183 Inches, and the breadth 30 Inches : If you divide the Diſtance upon your Line between theſe two Numbers into two equal parts, the Compaſs-point ſhall reſt upon 74 Inches 10 Parts: So that a Geometrical Square, whoſe ſide is 74. 10, ſhall be equal in Area to a Long-Square, whoſe Sides are 30 and 183.

So if you multiply 183 by 30, the Product will be 5490, whoſe Square Root is 74.1. And 74.1, multiplied by 74.1, produceth 5490.81, which is 5490.1, as near as can be eſtimated upon the Line.

A

A SUPPLEMENT.

To the Uſe of the Line *of* Proportion, *or* Numbers: *But more particularly to this 10th and the 17th Chap. following; performing the more difficult* Problems *concerning* Superficial *and* Solid Meaſures (*as* Board, Timber, Stone, &c.) *far more* Eaſily, Expeditiouſly, *and* Exactly, *than by the Ways there directed.*

FOR the effecting whereof it will be neceſſary (and ſo I would adviſe every *Artificer*) to have upon his *Two-foot Rule* (beſides the common *Double Line* of *Numbers*, as it is uſually put upon all *Two-foot Rules*) one other *Single-Line* of *Numbers* of one *Radius*, which muſt be exactly the Length of the other two, which are upon the common *two-foot Rules*; By which means theſe following (and many other *Problems*) will be far more eaſily and accurately performed than they can by the *Common Double-line* alone. I ſhall give you *Examples* of ſome few of them, whereby the reſt and (ſeveral others) will be the better apprehended.

PROP. I.

Having the Length and Breadth of a Parallelogram or Long-ſquare, given; to find the length of the Side of a Geometrical Square, whoſe ſuperficial Content ſhall be equal to the long Square.

THIS hath relation to what is done in the Tenth Chapter. And

I. *In Inch*-*MEASURE.*

Let the length of the Parallelogram *be* 183 Inches, *and the breadth* 30 Inches.——This is the Third *Example* of the *Tenth Chapter* before-going.

Take with your Compaſſes (out of the *Double-line* of *Numbers*) the Diſtance between 30 the *Breadth*, and 183 the *Length*. The Compaſſes opened to this Diſtance; Set one Foot in 30 (the leſſer Side) and the other will reach (upwards) to 74.1, in the *ſingle Line* of *Numbers*; and that is the Side of a *Geometrical Square* equal to the *Parallelogram* : Or,

The Compaſſes being opened from 30 to 183, in the *Double-line* ; If you ſet one Foot in 183 (the greater ſide) the other will reach (downwards) to 74.1 Inches, the Side of the Geometrical Square.

II. *In Foot-meaſure.*

Let there be an Oblong Superficies, *whoſe* Breadth *let be* 7.25 *Foot, and its* Length 32.5 *Foot: what ſhall the ſide of a* Geometrical Square *be,* whoſe Area *ſhall be equal to the given* Parallelogram?

Take in your Compaſſes the diſtance between 7.25 (counted in the lower part of the *Double-Line*) to 32.5 (counted in the upper part:) Then ſet one Foot in 32.5 counted in the *Single-Line*) and the other will reach (downwards) to 15.35 Foot, the ſide of the *Geometrical Square* required.

Example 2. *Let there be a* Parallelogram, *whoſe length is* 25.5. *Foot; and breadth* 12.3 *Foot: what is the ſide of a* Geometrical Square *equal thereunto?*

PROB. II.

To find the true Square of unequal ſided Timber or Stone.

I. *In Inch-meaſure.*

Example 1. *There is a ſquared Piece of* Timber, *whoſe Breadth at the End is* 13.2 *Inches, and Depth* 9.5 *Inches: What is the ſide of a Square equal thereunto?*

Take out of your *Double-Line* the diſtance between 9.5 and 13.2. With this diſtance, upon the *Single-Line*, ſet 1 Foot in 13.2, and the other will reach downwards to 11.1 Inches; the Side of the Square required.

Example 2. *There is a Stone whoſe Sides at the End are* 11 *Inches and* 18 *Inches: What is the Side of the Square equal thereto?*

Take the diſtance between 11 and 18, out of the *Double-Line*, and that will reach upon the *Single-Line* fro 11 (upwards) or from 18 (down wards) to 14.70 Inches, which i the Side of the Square required.

II. *In Foot-meaſure.*

Example 1. *There is a ſquared Pie of* Timber, *whoſe ſides at the En thereof are* 2.25 *Foot*, *and* 3.75 *Foo what is the ſide of a Square equal the End thereof?*

The diſtance between 2.25 and 75, taken out of the *Double-Line*, wi reach upon the *Single-Line* from 25 (upwards) or from 3.75 (dow wards) to 2.9 Foot, which is t ſide of the Square required.

III. *Of tapering Timber.*

This hath Relation to the Wo of the 17th Chapter following; a for it this one *Example* followi ſhall ſuffice.

Exam

Example. *Let there be a Piece of ſquared taper Timber, whoſe ſides at the greater End are 3.6, and 2.8 Foot; at the leſſer End 2.5, and 1.7 Foot; and the length thereof 23.4 Foot.*

1. Extend the Compaſſes from 1 to 2.8, the ſame Extent will reach from 3 6, to 10.08 Foot, the *Area* of the *Greater End.*

2. Extend the Compaſſes from 1, to 1.7, the ſame will reach from 2.5 to 4.25 Foot, the *Area* of the *Leſſer End.*

3. Take the diſtance (upon the *Double-Line*) between 4.25, and 10. ; that diſtance applied to the *Single-Line*, will reach from 4.25 to 6.54 (the *Geometrical Mean* between the *Areas* of the two *Ends.*)

4. Add the two *Areas* and this *Geometrical Mean* together, and their Sum will be 20.87.

The *Area* { of the greater End, 10.8
of the leſſer End, 4.2
the Geomet. Mean, 6.5
Their Sum 20.8

Now the Length of the Piece being 23.4 Foot, one Third part thereof is 7.8 Foot : Wherefore,

5. Extend the Compaſſes from to 7.8 Foot (which is One Thir part of the Length of the Piece) tha Extent will reach from 20.87 (th Sum of the *Areas* and Mean befor found) to 162.78 Foot : And tha is the true Content of the who Piece of Timber, which is 162 Foo and ſomewhat above 3 quarters of Foot.

Note, If this Piece had been meaſu red by adding the *Areas* of t two Ends together, and taking t half of them, and multiplying tha Half by the Length of the Piec the Quantity would be found to b 167.66 Foot, which is almoſt 5 Foo more than it ſhould be.

Wha

What is ſaid here concerning *Ta-ring Timber ſquared*, the like is to e underſtood of *Round Tapering imber*, or *Timber-Trees growing*.

CHAP. XI.

f *YARD-MEASURE by the Line.*

MANY Artificers, as *Joyners*, *Painters*, *Plaiſterers*, *Pavers*, *pholſters*, &c. meaſure and ſell their ork, not by the Foot, but by the rd: It will be neceſſary to give amples in this kind of Meaſure ſo. And here alſo it is requiſite, at your *Yard* be divided into 100 rts and not into Halves, Quar-rs, and Nails: Which ſuppoſed, ke theſe Examples following.

Example 1. *A Joyner hath wainſcotted a Gallery containing 130 Yard 25 parts about, and in height 15 Yards 50 parts; how many ſquare Yards are in that Gallery?*

The Proportion is,
As 1 yard,
to 15.50, yards the height:
So 130.25, the Compaſs in yards,
to 2018.87, the Content i
yards.

Extend the Compaſſes from 1 to 15.50, the breadth, the ſame exten will reach from 130.25, the length to 2018.87: and ſo many ſquar yards of Wainſcotting are, in tha Gallery.

Example 2. *A Painter hath painted Landskape, or other Work, over th Wainſcot of a Room, which is 1.7 parts of a Yard deep; how much i length thereof will make a Yar ſquare?*

A

As the breadth 1.75,
Is to 1 yard, or 100 parts:
So is 1, or any other Number of yards,
To the length of a yard ſquare.

Extend the Compaſſes from 1, in the middle, upwards, to 1.75; the ſame extent will reach from 100 (or one yard) at the end, downwards to 57.14: and ſo much in length of that painting will make a yard ſquare.

Example 3. *A Plaiſterer hath laid and beautified a Cieling, containing* 13 *yards broad, and* 63 *yards,* 30 *parts long; how many ſquare yards are there in that Cieling?*

As 1 Yard,
To the breadth 13.30,
So the Length 63.30,
To the Content.

Extend the Compaſſes from 1 to 13; the ſame extent will reach from 63.30, to 823 almoſt: and ſo many ſquare Yards are there in ſuch a Cieling.

Note, It may ſo fall out ſometimes, that it may be required to meaſure ſome piece of Work, and to give an eſtimate of the quantity of the Yards therein contained, when you have not a Yard thus divided by you, but only your Two-foot Rule, for the ſupplying whereof, I will add this following Problem.

PROBLEM.

The length and breadth of any Superficies being given in Feet, to find the Content thereof in Yards.

Let the breadth of a piece of any Work, to be meaſured by the yard, be 4 Foot, and the length thereof 12 Foot, how many ſquare Yards are contained therein?

The Analogy or Proportion is,
As 9, the Feet in one Yard,
is to 4, the breadth in Feet,

So is 12, the length in Feet,
to 5.33, the content in Yards.

Extend the Compaſſes from 9 to 4, he ſame extent will reach (the ſame ay) from 12 to 5.33. that is, to 5 ards and 33 hundred parts of a ard, which is 5 Yards, one Quarter, and almoſt half a Quarter of a ard.

And what is here ſaid of meaſuring by the Foot, and giving of the Content in Yards, the ſame may be ffected if the Dimenſions be taken n Feet, and the Reſult required in Ells, or other Meaſure.

CHAP. XII.

Of LAND-MEASURE *by the Line.*

THE uſual Meaſures for Land are *Chains*, of which there are divers ſorts; but the Denominations that the quantity of Land is given in by, are *Acres* and *Perches*.

The *Chains* now moſt in uſe are principally two,

One containing 1 Perch in length,
The other 4 Perches in length,
} each of them divided into 100 Links.

For the Practice of them, take theſe Examples.

I. *By the One Pole-Chain.*

Example 1. *There is a Plat of Ground 30 Perches broad, and 183 Perches long; how many Perches doth it contain?*

As 1,
to 30, the breadth in Perches;
So 183 the length, in Perches,
to 5490, the Content in Perches.

Extend the Compaſſes from 1 to 30, that extent ſhall reach from 183 to 5490, the Content in Perches.

Example 2. *But the length and breadth of the ſame piece of Ground being given as before in Perches; if it were required to find the Content in Acres,* Then the Proportion will be,

As 160 Perches,
  to 30 the Breadth, in Perches;
So 183, the Length in Perches,
  to 34.31 Acres.

Extend the Compaſſes from 160 to 30; the ſame extent will reach (the ſame way) from 183 to 34.31, that is, 34 Acres, 31 hundred parts of an Acre, which is ſomething above a Rood.

II. *By the Four Pole-Chain.*

Example 1. *A Piece of Land containing 16 Chains, 25 Links in breadth, and 57 Chains, 30 Links in length, how many Acres doth it contain?* The Analogy is,

As 10,
to 16.25, the breadth in Chains, and Links;
So is 57.30, the length in Chains,
to 93.11255 Acres, and parts of an Acre.

Extend the Compaſſes from 10 to 16.25, the ſame extent will reach from 57.3, to 93.11255; that is, 93 Acres, and 11255 parts of an Acre.

Example 2. *The Baſe and Perpendicular of a Triangle being given in Chains and Links, to find the Content in Acres.*

This is a right, uſeful, and neceſſary Propoſition: For by it all manner of irregular Plats of Land are caſt up: But my Intent here is not to teach Surveying, but to ſhew the Uſe of the Line of Proportion.

Wherefore let the Perpendicular of a Triangle be 7 Chains 50 Links, and the Baſe 45 Chains 75 Links, the Proportion will be,

As 2,
to 7.50, the Perpendicular:
So is 45.75, the Baſe,
to 17.15, the content in ſquare Chains.

Extend the Compaſſes from 2 to 7.50, that extent ſhall reach from 45.75, to 17.15, which is 17 Acres, and $\frac{15}{100}$ parts.

Example 3. *Having the length of any Furlong given, to find what breadth it muſt have to make an Acre.*

Let the length of the Furlong be 12 chains 50 links: then to find the breadth for one Acre, this is the Analogy;

As 15.20, the length in Chains, is unto 10:
So is 1 Acre,
to 80 links, which muſt be the breadth of the Furlong.

Wherefore,

Extend the Compaſſes from 1, in the middle upwards, to 12.50, the ſame will reach from 1 in the middle, downwards to 80 links, the breadth of the Furlong.

CHAP. XIII.

PROB. I.

THe Area, *or* Superficial Content *of any Piece of* Land *being given, according to one kind of* Perch; *To find how much the ſame* Piece *of* Land *would contain, if it were meaſured with a* Pole *or* Perch *of another* Length, *differing from the former.*

Like Plains are in Proportion to another, as are the *Squares* of their *Homologal Sides*. And therefore, the *Proportion* to reſolve this *Problem* is this following, *viz.*

As the *Square* of the *Perch* (*Rod* or *Pole*) by which the *Land* is to be *meaſured*,
Is to the *Square* of the *Pole* or *Perch*, by which it was meaſured,
So is the *Area* (or *Content*) given,
To the *Area* or *Content* required.

Ex-

Example.

Suppoſe a Wood (*or other Piece of* Land) *has been meaſured by a* Chain *of* 18 *Foot, to the* Rood, Pole *or* Perch; *and by ſuch a* Chain *it was found to contain* 61 Acres, *and* 3 *tenth parts of an* Acre : *and it were required to find how many* Acres *the ſame Piece of* Land *would contain, if it had been meaſured by a* Pole, Rood *or* Perch, *of* 16 *Foot and a half, which is the* Statute-Pole *or* Perch.

The Proportion is,

As the *Square* of 16.5 Foot, (the *Pole* by which the *Land* is to be meaſured) which is 272.25,

Is to the *Square* of 18 Foot, (the *Pole* or *Perch* by which the *Land* was meaſured) and is 224;

So is 61.3 *Acres* (the quantity as meaſured by the 18 Foot *Perch*;)

To 73, (the quantity of *Acres* that it would contain, if it had been meaſured, by a *Statute-Pole* of 16.5 Foot.)

Wherefore

Extend the Compaſſes from 16.5, to 18; the ſame extent will reach (the ſame way) from 61.3 *Acres* (the Content given;) to another number (*viz.*6.63) upon the Line; and from that other Number forward, to 73 Acres, the Content if meaſured by a Statute-Pole of 16.5 Foot.

But (on the contrary) if the piece being meaſured by a Chain of 16.5 Foot, ſhould have contained 73 Acres, and it had been required to know how many *Acres* it would have contained, if it had been meaſured by a Chain of 18 Foot to the *Pole*; then, the *Operation* upon the Line would be thus;

Extend the Compaſſes from 18 (downwards) to 16.5; the ſame extent will reach the ſame way, (*viz.* downwards) from 73 Acres to a Fourth Point (or Number) upon the Line: and from that Point (or Number) downwards to 16.3 Acres;

And ſuch would the quantity of Acres have been, if it had been meaſured by a *Cuſtomary Pole* or *Perch* of 18 Foot.

PROB. II.

The Area, *or* Content *of any* Plot *of* Land *being given; and the* Scale *by which it was laid down, being either* Omitted, Loſt, *or* Conceal'd: *To find the* Scale *by which it was* plotted.

Let there be given you the Figure of a *Piece of Land*, which is ſaid to contain 8 Acres, and if you would know by what *Scale* it was laid down, or *Plotted*; do thus;

Firſt take any *Scale* (as ſuppoſe one of 12 Pole in an Inch) and caſt up the Content of the *Plot* thereby; and ſo doing, ſuppoſe you find the ſame *Plot* to contain 11.5 Acres, that is 11 Acres and a half: and now, to find the true *Scale* by which it was plotted, this is the *Analogy* or *Proportion.*

As the quantity of Acres found, by the *Scale* of 12 (*viz.* 11.5 *A.*)
Is to the *Square* of the *Scale* 12.(*viz.* 144;)
So is the quantity of *Acres* given, (*viz.* 8,)
To 105, the *Square* of the *Scale* by which it was plotted, (*viz.* 10.)

So,

If you extend the Compaſſes from 11.5 Acres downwards to 8 Acres. The ſame extent will reach from 114 (downwards to 10, the *Scale* by which the *Ground* was laid down or plotted.

CHAP. XIV.

Of the Menſuration of divers Regular SUPERFICIAL FIGURES by the Line.

HAving ſufficiently ſhewn the manner of meaſuring of ſuch

Superficial Figures as are meaſured by length and breadth, I will now ſhew you how by the Line to meaſure ſome other Regular Figures, as the Circle, *&c.*

I. *Of the Circle.*

Example 1. *The length of the* Diameter *of any* Circle *being given, to find the* Circumference *thereof.*

The Proportion between the *Diameter,* and the *Circumference* of any *Circle* is as 7 to 22; or in exacter terms, as 1.000 to 3.14.

Wherefore,

If the Diameter of a Circle be 12 Inches, the Circumference thereof may be found by this following Analogy:

As 1.000,
Is to 3.14:
So is 12 the Diameter,
to 37.68, the Circumference.

Wherefore extend the Compaſſes from 1.000 to 3.14. the ſame extent will reach from 12 to 37 Inches, 68 Parts; which is the Circumference.

Example 2. *The* Circumference of *any Circle being given, to find the length of the* Diameter.

This is the converſe of the former Example, and the Analogy is the converſe alſo.

Let the Circumference of a Circle be 37 Inches 68 Parts, what is the length of the Diameter?

As 3.14,
to 1.000:
So is 37 Inches, 68 Parts the Circumference,
to 12 Inches, the Diameter.

Extend the Compaſſes from 3.14, downwards, to 1.000; the ſame extent will reach, the ſame way, from 37.68, to 12, the Diameter required.

Example 3. *Having the* Diameter *of a* Circle, *to find the length of the* Side *of a* Square *which ſhall be equal in content to the ſame* Circle.

If the Diameter of a Circle be 12 Inches, the Proportion is,

As 1.000,

Is to 12 Inches, the Diameter;

So is 8862,

To 10.63, the Side of the Square.

Extend the Compaſſes from 10000 (or from 1 in the middle) upwards, to 12, the Diameter; the ſame Extent will reach from 8862, counted in the lower Part of the Line, upwards, to 10 Inches, 63 hundred parts, the Side of a Square equal in *Area* to the Circle, whoſe Diameter is 12 Inches.

Example 4. *Having the* Circumference *of a* Circle *given, to find the Side of a* Square *equal to that* Circle.

Let the Circumference of the given Circle be 37 Inches, 68 Parts: The Proportion is,

As 10000,
to 37.68, the Circumference:
So is 2821
to 10.63, the ſide of the Square.

Extend the Compaſſes from 10000 (or 1 in the middle) upwards to 37.68, the ſame extent will reach from 2821 upwards, to 10 Inches, 63 parts, the ſide of the Square required.

Example 5. *The* Diameter *of a* Circle *being given, to find the* Superficial Content thereof.

Let the Diameter of a Circle be 15 Inches.

Extend the Compaſſes from 1 to 15, the Diameter; then apply one Foot of that diſtance (always) to 78.54, and turn that diſtance twice from this Number, the ſame way, and the Compaſs-point will fall up-176 Inches, 74 parts; which is the *Area* of that Circle whoſe Diameter is 15 Inches.

Example 6. *The Circumference of a Circle being given, to find the Area thereof.*

Let the Circumference of a Circle given be 47 Inches. 13 Parts.

Extend the Compaſſes from 1, to 47.13, the Circumference; this diſtance being applied (always) to this Number 7958, and from thence twice repeated, the Point of the Compaſſes at the ſecond remove, will fall upon 176 Inches, 74 Parts, equal to the Area of the Circle, as before.

Here note, That your Compaſſes being opened from 1 to 37.13, the Circumference, when you come to ſet one Foot upon 7958, the other will reach at your firſt turning over to 29.55 ; and when you turn them over again, it will fall out of the Line: Wherefore you muſt ſet one Foot in 29.55, in the lower part of the line, and then the other will fall upon 176.74 ; and this you muſt do in other

Caſes whenever your Compaſs-point goes beyond your Line.

CHAP. XV.

II. *Of the* TRIANGLE.

A *Triangle* is a Figure conſiſting of three *Sides* and three *Angles*, the longeſt *Side* whereof we call the *Baſe* ; and a Line drawn from the *Angle* oppoſite to the *Baſe*, we call the *Perpendicular*.

To meaſure *Triangles* there are ſeveral ways ; I will only ſhew you one or two to be done by the Line.

Example 1. *There is a* Triangle *whoſe* Baſe *is* 14 *Foot, and his* Perpendicular 6 *Foot* ; *I would know how many ſquare Feet are contained in this* Triangle.

The Proportion is,

1. As 2,
is to 6, the Perpendicular;
So is 14, the Baſe,
to 42, the Area.

Or,

. As 1,
is to 3, half the Baſe;
o is 14, the Baſe,
to 42 the Area.

Or,

. As 2,
is to 6, the Perpendicular;
o is 7, half the Baſe,
to 42, the Area.

Or,

As 1,
is to 6, the Perpendicular;
is 14, the Baſe,
to 84, the double Area.

All theſe Ways produce the ſame
fect; but the firſt is the beſt:

Wherefore,

The *Baſe* of your Triangle being
, and the *Perpendicular* 6,

For the Firſt way,

Extend the Compaſſes from 2 to 6 ; the ſame Extent will reach fro 14 to 42, the Area.

For the Second way,

Extend the Compaſſes from 1 t 3 ; the ſame Extent will reach fro 14, to 42.

For the third way,

Extend the Compaſſes from 2 t 6; the ſame Extent will reach fro 7, to 42.

For the Fourth way.

Extend the Compaſſes from 1 t 6; the ſame Extent will reach fro 14, to 84; which is the double of 4 the Area.

III. *Of the* Trapezium.

A *Trapezium* is any right lin Figure conſiſting of 4 unequal Side and as many unequal Angles.

For the meaſuring of it, you mu firſt reduce it into two *Triangles*, b

dra

drawing a Line or *Diagonal* from one oppoſite *Angle* to another, the longeſt way; then from the two *Angles* oppoſite to this *Line*, let fall two *Perpendiculars*; ſo is the *Trapezium* divided into two *Triangles*. The manner how to meaſure it, is as followeth.

Example. *There is a* Trapezium, *whoſe* Diagonal *is* 12.34, *and one* Perpendicular *is* 4.20, *the other* 5.70; *I would know the Content or* Area *thereof.*

The two Perpendiculars added together; make 9.27. Then the Analogy is,

As 2,
is to 9.27, the Sum of the Perpendiculars;
So is 12.34, the Baſe or Diagonal to 57.17, the Area.

Extend the Compaſſes from 2, to 9.27; the ſame Extent will reach (the ſame way) from 12.34, to 57.

77, which is the Area, or Superficial Content of the *Trapezium*.

There are as many ways to meaſure *Trapeziums*, as in the laſt *Example* I gave you for *Triangles*; bu this is the beſt.

And here note, That if you are t meaſure any irregular Piece, o what nature ſoever, whether *Land*, *Board*, *Glaſs*, *Pavement*, or the like your beſt and exacteſt way is to reduce them to *Trapeziums*, and meaſure them as before is taught.

IV. *Of* Regular Figures *of* 5, 6, 8, 10, *or* 20 *equal Sides.*

Theſe Figures by Geometricians are called *Regular Polygons*; and th way to meaſure them, is by addin all the Sides together: Then meaſur the length from the Centre of th *Figure*, to the middle of one of th *Sides*. By the help of theſe two yo may find the Area of the Figure: a followeth.

Exam-xample. *Let there be a* Regular Polygon *of* 11 *equal Sides, each Side being* 7 *Inches, and let the length of the Line from the* Centre, *to the middle of one of thoſe Sides, be* 12 *Inches.*

Add all the Sides together, they ake 77; then,

As 2,
is to 77, the Sum of the Sides;
So is 12 Inches the length of the Line from the middle of the *Figure*,
to 462, the Content of the Figure.

Extend the Compaſſes, from 2, the under part of the Line, to 77, ounted alſo in the under part of e Line:) The ſame Extent will ach from 12 (counted in the upper-part of the Line) to 462, which the true Content of the *Polygon* Feet.

CHAP. XVI.

The Uſe of the LINE applied to SOLID MEASURE, ſuch as Timber, Stone, *&c.*

TImber and Stone are uſually meaſured by the ſame *Rule* or *Meaſure* as *Board* and *Glaſs* are, namely, by *Feet* and *Inches*: Therefore ſuch a Rule as was mentioned in the beginning of the *Tenth Chapter*, is fit for this Buſineſs alſo.

Before we come to ſhew the way of Meaſuring of *Stone* or *Timber*, it will be neceſſary to premiſe thus much; That the *Baſe* or *End* of every piece of *Timber* or *Stone* is (or muſt be ſuppoſed) either exactly ſquare, that is, every Side alike, or elſe one of the Sides longer than the other: wherefore the firſt thing to be done, is to find the *Area* or *Superficial* content of the *Baſe*, or end of any piece of *Timber* or *Stone* to be meaſured; which may be done ſeveral ways, either in Inch-meaſure, as by the firſt *Example* of the firſt part of the *Tenth Chapter*; or in *Foot-meaſure*, by the firſt *Example* in the ſecond part of the ſame *Chapter*; or both in *Foot-meaſure* and *Inch meaſure*, as in the firſt *Example* of the third part of the ſame *Tenth Chapter*, and therefore need not be here repeated again: Wherefore, we will proceed to our intended purpoſe of *Meaſuring*, firſt, by *Inch-meaſure* only; ſecondly, by *Foot-meaſure* only, and thirdly by both together: As we did before in the *Meaſuring of Board*, &c.

I. *In Inch-meaſure only.*

Example 1. *There is a piece of* Timber 30 *Inches broad,* 21 *Inches,* 6 *parts deep, and* 183 *Inches long; how many ſquare Inches are there in this ſolid piece of* Timber?

The Proportion is,

1. As 1,
is to 30 Inches the Breadth;
So is 21.6 Inches, the Depth,
to 648 Inches, the Content of the Baſe of the piece.

2. As 1,
is to 648, the Content of the Baſe;
So is 183 Inches, the length of the piece,
to 118584, the ſolid Content in Inches.

Wherefore, Extend the Compaſſes from 1 to 30, the breadth; the ſame will reach from 21.6, the depth, to 648, the Content of the Baſe.——

Again, Extend the Compaſſes from 1 to 648, the Content of the Baſe; that extent will reach from 183, the length, to 118584 Inches, the ſolid Content. But ſo many places of Figures can't well be eſtimated upon your Line, except it be very large; but by the following Examples you ſhall have your deſire accompliſhed exactly and eaſily.

Example 2. *To find the Content of the ſame piece of* Timber *in* Foot-meaſure, *the Dimenſions being given in* Inches *and Parts?*

The Proportion is,

1. As 1,
   is to 30, the Breadth;
   So is 21.6, the Depth,
   to 648, the Content of the Baſe, as before.
2. As 1728, the number of ſolid Inches in a Foot of Timber,
   is to 648, the Content of the Baſe;
   So is 183, the length in Inches,
   to 68 Foot, and 42 parts of a Foot, as before.

Wherefore, as before, extend the Compaſſes, from 1, to 30, the Breadth, the ſame will reach from 21.6, the Depth, to 648, the Content of the Baſe, as before.——

Again, extend the Compaſſes from 1728, (calling the 1 in the middle of the Line 1000) downwards to 648, the Baſe (counted in the under-part of the Line:) The ſame Extent will reach the ſame way, from 183, the length (counted in the upper-part of the Line) downwards, to 68.62, the Content of the piece of Timber in Feet and Parts, that is, 68 Foot, and above half a Foot.

Example 3. *Let a ſquare* Stone, *or piece of* Timber *be* 30 *Inches broad, and* 21 *Inches*, 6 *parts deep; how much in length ſhall make a Foot ſquare of that piece of* Timber *or* Stone?

You may find the Content of the Baſe, as in the laſt Example, to be 648 Inches: Then the Proportion is,

As 648, the Content of the Baſe,
is to 1728, the Inches in a Foot;
So is 1,
to 2 Inches, 67 Parts, the length of a Foot ſolid.

Therefore extend the Compaſſes from 648, the Baſe, to 1728; the ſame will reach from 1 to 2.67: So that 2 Inches, 67 Parts, will make a Foot ſolid of that piece of Timber or Stone.

This may be done another way, by this Analogy or Proportion.

1. As 12,
is to 30, the Breadth in Inches,
So is 21.6, the Depth in Inches,
to a fourth Number (which here will be about 54.)
2. As the fourth Number 54,
is to 144;
So is 1,
to 2.67, the length of a Foot ſolid.

Wherefore extend the Compaſſes from 12 to 30, the breadth, that Extent will reach from 21.6, the depth, to a certain place upon the Line (about 54) where keep the Point of the Compaſs faſt, and open the other to 144; then will this Extent of the Compaſſes reach from 1 to 2 Inches, 67 parts, the length of a Foot ſolid, as before.

II. *In Foot-meaſure only.*

Example 1. *Let a* Stone *or a piece of* Timber *be* 2 *Foot*, 50 *parts broad*, 1 *Foot*, 80 *parts deep, and* 25 *Foot*, 15 *parts long, how many ſolid or cubical Feet doth ſuch a piece contain?*

The Proportion is,

1. As 1,
   is to 2.50 Foot, the Breadth:
So is 1.80 Foot, the Depth,
   to 4.50 Foot, the Baſe in Foot-meaſure.
2. As 1,
   is to 4.50, the Baſe;
So is 15.25, the Length,
   to 68.62, the Content in Feet.

Example 2. *In the forementioned piece of ſquared Stone or Timber, being 2 Foot, 50 parts broad, and 1 Foot, 80 parts deep, Let it be required to find how much thereof in Length will make a Foot.*

The Proportion is,

1. As 1,
   is to 2.50, the Breadth;
So is 1.80, the Depth,
   to 4.50, the Content of the Baſe, in Foot-meaſure.
2. As 4 50, the Baſe,
   is to 1,
So is 1 Foot,
   to 222 parts, the Length of a Foot ſolid.

Wherefore, Extend the Compaſſes from 1, at the beginning of the Line, to 2.50, the breadth; the ſame Extent will reach from 1.80, the depth in the under-part of the Line, to 4.50, the Content of the Baſe.— Again, Extend the Compaſſes from 4.50, the Baſe, (counted in the upper-part of the Line) downwards to 1, in the middle of the Line; the ſame will reach from 10, at the end of the Line, downwards, to 222 parts, the Length of a *Cubical* or *Solid Foot* of that *Stone* or Piece *of Timber.*

III. *In* FOOT-*MEASURE and* INCH-*MEASURE together.*

Example. *Let a ſquared Stone or piece of Timber be* 30 *Inches broad,* 27.6 *Inches deep, and* 15 *Foot,* 25 *parts long; How many* Cubical *or* Solid *Foot of Stone or Timber are there in that Piece?*

The Proportion is,

1. As 1,
is to 30 Inches, the Breadth;
So is 21.6 Inches, the Depth,
to 640, the Content of the Baſe in Inches.

2. As 144 the Inches in a Foot Superficial,
is to 648, the Content of the Baſe in Inches :
So is 15.25, the Length of the Piece in Foot-meaſure,
to 68 Foot, 62 Parts.

Wherefore extend the Compaſſes from 1 to 30, the Breadth : the ſame will reach from 21.9, the depth, to 648, the Content of the Baſe.——

Again, extend the Compaſſes from 144, to 648, the Content of the Baſe ; the ſame Extent will reach from 15.25, the length of the piece, to 68.62, the ſolid Content of the Stone or Timber in Feet, and 100 parts of a Foot.

By having the ſame things given in the ſame piece of Stone or Timber (or in any other) the Work may be varied ſeveral ways : The Analogies or Proportions I will only give you, leaving the Practice thereof to your ſelf.

Breadth of the Piece, 30 Inches.
Depth of the Piece, 21.6 Inches.
Length of the Piece, 15.25 Foot.

The Proportion is,

1. As 144,
is to 30, the Breadth:
So is 21.6, the Depth,
to a fourth Number.

From which fourth Number, if you extend your Compaſſes to 1, and place one Foot in 15.25, the length of the Piece, the other Foot ſhall fall upon 68.62, the Content of the Stone.

Or,

2. As 12,
is to 30, the Breadth;
So is 12.6, the Depth,
to ſome fourth Number.

From this fourth Number extend the Compaſſes to 12, that diſtance will reach from 15.25, the length of the Piece, to 68.62, the Content of that Piece.

CHAP. XVII.

How to meaſure Stone *or* Timber *by the Line, by having the* Square *of the* Baſe, *and the* Length *of the Piece given, both in* Foot *and* Inch-meaſure.

HOW to find the Length of a Side of a *Geometrical Square*, that ſhall be equal to any *Parallelogram*, or *Long-Square*, is taught at the latter end of the Tenth Chapter of this Book, by which Rule it may at any Time be found. That being done there, I ſhall only here begin with Examples.

Example 1. *There is a ſquared Piece of Timber, whoſe Length is* 183 *Inches, and the ſide of the Square, equal to the Baſe or End thereof, is* 25 *Inches,* 45 *Parts; how many Foot doth that piece contain?*

1. As 41.57,
is to 25.45, the ſide of the Square;
So is 183, the Length in Inches,
to a fourth Number,
2. And that fourth Number,
to 68.82, the Content in Feet.

Extend the Compaſſes from 41.57, to 25.45, the ſide of the Square; the ſame will reach from 183, the length, to ſome other part of the Line; from whence if you again extend the ſame diſtance, the Point will reſt upon 68 Foot, 62 parts of a Foot; and ſo many Foot are in the Piece.

Example 2. *Let the ſide of a Square, equal to the Baſe of a piece of Stone or Timber, be 2 Foot, 12 parts, and the length of the ſame Piece 15 Foot, 25 parts; how many ſolid Foot are there in that Piece?*

1. As 1,
is to 2 Foot, 12 Parts, the ſide of the Square;
So is 15 Foot, 25 parts, the length,
to a fourth Number:

2. And that fourth Number,
to 68.62, the Content in Feet.

Extend the Compaſſes from 1, in the middle, upwards, to 2.12, the ſide of the Square; that will reach from 15.25, the lentgh, to ſome other Number on the Line: From whence the Compaſſes being extended (or turned upwards) the moveable Point will fall upon 68.62, the Content, as before.

Example 3. *The ſide of a Square, equal to the Baſe of a Stone, being 25 Inches, 45 parts, and the length of that Stone 15 Foot, 25 parts, how many Foot doth it contain?*

1. As 12,
is to 25.45, the Square in Inches:
So is 15.25 Foot the length,
to a fourth Number:
2. And that fourth Number,
to 68.62, the Content.

Extend the Compaſſes from 12 to 25.45, the ſide of the Square; the ſame will reach from 15.25, to ſome other point upon the Line, from whence the Compaſſes being extended or turned upwards, the moveable Point will fall upon 68 Foot, 62 Parts, the Content of the Stone.

Example 4. *There is a piece of Timber whoſe ſide of the Square of the Baſe is 25 Inches, 45 Parts, how much in length of that Piece will make a Foot ſolid?*

1. As 25.45, the ſide of the Square,
   is to 1 Foot;

So is 41.57,
   to a fourth Number.

2. And that fourth Number,
   to 6 Inches, 67 Parts.

Wherefore, Extend the Compaſſes from 25.45, the ſide, downwards, to 1 in the middle of the Line; the ſame will reach from 41.57, downwards to ſome other Point, from whence the Compaſſes being turned ſtill downwards, will reach to 6.67, the length of a Foot ſolid of that Picee of Timber.

Example 5. *The length of the ſide of a Square, equal to the Baſe of a piece of Timber being 2 Foot, 12 parts, to find how much in length of that piece will make a Foot ſolid in Foot-meaſure.*

As 2.12, the ſide of the Square,
is to 1.00;
So is 1.00,
to a fourth Number.
2. And that fourth Number,
to 222 parts of a Foot, to make
a Foot-ſquare,

Extend the Compaſſes from 2.12, the ſide of the Square, downwards to 100; the ſame extent will reach from 100, downwards to ſome other Point upon the Line, and from thence ſtill downwards, to 222 parts of a Foot; and ſo much in length will make a Foot-ſolid.

CHAP. XVIII.

Concerning Timber *that is bigger at one end than at the other, either* Round *or* Square; *and how to meaſure it.*

I. *For SQUARED-TIMBER.*

IN large Timber-Trees, when they are ſquared, there is a great diſproportion between the Squares of both ends; wherefore ſome do uſe to take the ſquare of the middle of the Piece for the mean or true ſquare, but this is not exact, though much uſed; but the beſt way is this: Find by the Problem at the end of the Tenth Chapter of this Book, the length of the ſide of a Square equal to both the ends of the Piece, add theſe two ſides together, and take the half thereof for the true Square:

and with that Square you may by the Rules of the laſt Chapter meaſure it as if it were perfectly ſquare.

But this way is not exact neither: for it is not the Arithmetical Mean, but the Geometrical Mean, which gives the true Square: As by the Supplement at the end of the Tenth Chapter you may ſee.

II. *For ROUND-TIMBER.*

The ordinary way uſed for the meaſuring of Round-Timber, is to girt it about the middle with a Line, and to take one fourth part thereof for the ſide of a Square equal thereto: But this is falſe, though moſt Men uſe it, Cuſtom having made it bear the Face of Truth: For it is more in meaſure than in reality it ſhould be, by about one fifth part.

But the exact way of meaſuring of Round Timber (eſpecially if it be growing) is this: About the middle thereof, in ſome ſmooth place, girt the ſame about with a String: Then have you this Proportion;

As 1000,
  is to the number of Inches about;
So is 2821,
  to the length of the ſide of a Square equal thereunto.

So if a Tree being girt about, as aboveſaid, ſhall contain in circumference 47 Inches, 13 parts.

If you extend the Compaſſes from 1000 to 47 Inches, 13 parts, the ſame extent will reach from 2821, to 13 Inches, 29 parts, which is equal to to the ſide of a Square equal to that Tree; which being obtained, the Tree may be meaſured divers ways, according to the Examples in the laſt Chapter.

CHAP. XIX.

Concerning the meaſuring of Regular Solids, or Cylinders, Globes, Cones, and ſuch like.

I. *Of the* CYLINDER.

A *Cylinder* is a round Figure, of equal Circumference in all arts thereof, as a ſtanding Pillar, Rowling-ſtone for Garden-walks, c. To meaſure ſuch a Figure there e ſeveral ways, both by having e Circumference given when it is anding, or by having the Diame- r at the end thereof when it is ing, or by having the ſide of a quare equal to the Baſe thereof,

I. *By having the Diameter given.*

Example 1. *The Diameter being* 15 *Inches, how much in length makes a Foot?*

As 15, the Diameter,
 to 46.90:
So is 1,
 to a fourth;
And that fourth,
 to 9.78, the length of a Foot.

Extend the Compaſſes from 15 the Diameter, to 46.90: that exten will reach from 1 to another Poi upon the Line, and from thence t 9 Inches, 78 Parts, the length of Foot ſolid.

Example 2. *The Diameter being Foot,* 25 *parts, how much in leng makes a Foot in Foot-meaſure.*

As 1.25, the Diameter in Feet,
 to 1.128:
So 1,
 to a fourth Number;
And that,
 to 8.14, the length of a Foot ſolid in Foot-meaſure.

Extend the Compaſſes from 1.25, the Diameter, to 1.128; the ſame will reach from 1 to ſome other Number, and from thence to 1 Foot, 128 parts of a Foot, the length of a Foot ſolid.

Example 3. *Having the Diameter, 15 Inches, and the length, 105 Inches; How many ſolid Inches doth the Cylinder contain?*

As 1.128,
 to 15 Inches, the Diameter;
So is 105 Inches, the length,
 to a fourth Number;
And that,
 to 18555.34 Inches, the Content.

Extend the Compaſſes from 1.128 to 15, the length: the ſame extent will reach from 105, the length, to ſome other Number, and from thence to 18555.34 Inches, the Content of the Cylinder in Inches.

Example 4. *Having the Diameter 1 Foot, 25 parts, and the length 8 Foot, 75 parts, to find the Content in Feet.*

As 1.128,
  to 1.25, the Diameter:
So is 8.75, the length,
  to a fourth;
And that fourth,
  to 10.74 Foot the content.

Extend the Compaſſes from 1.128 to 1.25, the Diameter: the extent will reach from 8.75, the length, to ſome other Number, and from that to 10 Foot, 74 parts, the content.

Example 5. *Having the Diameter 15 Inches, and the length 105 Inches, how many Foot doth it contain?*

As 46.90,
to 15 Inches, the Diameter;
So is 105 Inches, the length,
to a fourth :
And that fourth,
to 10 Foot, 74 parts, the Content.

Extend the Compaſſes from 46.90 to 15, the Diameter : That extent will reach from 105 the length, to another Number, and from that to 10 Foot, 74 parts the Content.

Example 6. *The Diameter being 15 Inches, and the length 8 Foot, 75 parts, how many Foot doth it contain ?*

As 13.54,
to 15 Inches, the Diameter :
So 8.75 Foot, the Length,
to a fourth :
And that fourth,
to 10.74, the length in Feet.

Extend the Compaſſes from 3.54 o 15, the length : that Extent will reach from 8.75, the length, to another Number, and from thence to

10.74 Foot, the Content in Feet.

II. *By having the Circumference given.*

Example 1. *The Circumference of a Cylinder is 47 Inches, 13 parts; how much thereof in length ſhall make a Foot ſolid?*

As 47.13 Inches, the Circumference,
to 147.36:
So 1,
to a fourth Number:
And that,
to 9.78 Inches, the length of a Foot.

Extend the Compaſſes from 47.13, the Circumference, to 147.36: that extent will reach from 1 to a fourth Number, and from thence to 9 Inches, 78 parts, the length of a Foot ſolid.

Example 2. *Having the Circumference of a Cylinder, 3 Foot 927 parts, to find the length of a Foot ſolid thereof in Foot-meaſure.*

As 3.927 Foot,
to 3.545:
So 1,
to a fourth Number:
And that,
to 815 parts of a Foot, the length.

Extend the Compaſſes from 3.927 he Circumference, to 3.545: that extent will reach from 1 to ſome other Number, and from thence to 815 parts of a Foot, for the length of a ſolid Foot of that Cylinder.

Example 3. *The Circumference of a Cylinder being* 47 *Inches*, 13 *parts, and the length thereof* 105 *Inches, How many Inches are there in ſuch a Cylinder?*

As 3.545,
to 45.13, the Circumference;
So 105 Inches, the length,
to a fourth Number:
And that,
to 18555, the Content in Inches.

Extend the Compaſſes from 3.545 to 47.13, the Circumference; that extent will reach from 105, the length, to another Number; and from thence to 18555, the number of ſolid Inches in the Cylinder.

Example 4. *The Circumference being 47 Inches, 13 parts, and the length 105 Inches (as before); How many ſolid Foot in that Cylinder?*

As 147.36,
to 47.13 Inches, the Circumference;
So 105 Inches, the length,
to a fourth Number:
And that,
to 10 Foot, 74 parts, the Content.

Extend the Compaſſes from 147.36 to 47.13, the Circumference, that extent will reach from 105, the length, to another Number; and from that, to 10 Foot, 74 parts of a Foot, the ſolid Content.

Example 5. *Let the length of the Cylinder be 8 Foot, 75 parts, and the Circumference 3 Foot 927 parts: How many Foot doth it contain?*

As 3.545,
to 3.927 Foot, the Circumference:
So 8.75 Foot, the length,
to a fourth Number:
And that,
to 10 Foot,74 parts, the Content.

Extend the Compaſſes from 3.545, to 3.927: The ſame Extent will reach from 8.75, the length, to 10.74, the content in Feet.

Example 6. *Let the Circumference given be 47 Inches, 13 parts, and the length 8 Foot, 75 parts: How many ſolid Feet doth the Cylinder contain?*

As 42.54,
to 47.13 Inches, the Circumference:
So is 8.75 Foot, the length,
to a fourth:
And that fourth,
to 10.74 Foot, the Content.

Extend the Compaſſes from 42.54 to 47.13, the Circumference: that extent will reach from 8.75, the length, to another Number, and from thence to 10 Foot, 74 parts, the Content of the Cylinder in ſolid Feet.

III. *By having the Side of a Square, equal to the Baſe or End of a Cylinder.*

Example. *Let the Side of a Square, equal to the Baſe or End of the Cylinder, be 13 Inches, 29 parts, and the Length thereof 105 Inches; How many ſquare Feet are contained in that Cylinder?*

As 41.57;
to 13.29 Inches, the Side of the Square:
So is 105, the length in Inches,
to a fourth Number:
And that,
to 10 Foot, 47 parts, the Content of the Cylinder in Feet and parts.

Extend the Compaſſes from 41.54, to 13.29 Inches, the ſide of a Square equal to the Baſe of the Cylinder; that extent will reach from 105 Inches, the length, to another Number, and from thence, to 10 Foot 47 parts, the Content of the Cylinder in Feet.

II. *Of the* CONE.

A *Cone* is a round Figure, having for the Baſe thereof a Circle, the Side whereof riſeth from the Circumference of the Circle round about the ſame equally, till it meet in a point juſt over the Center of the Circle, and is in the form of a Spire-ſteeple And it is thus meaſured.

Example 1. *Let there be a Cone, the Diameter of whoſe Baſe is 10 Inches, and whoſe Height is 12 Inches, I would know how many ſolid or Cubical Inches are contained therein.*

The Diameter being 10, the Content of the Circle or Baſe will be found to be 78 Inches, 54 parts, as by the fifth Example in Chap. 13. of this Book.

The Area of the Baſe being thus found, the Proportion is,

As 3,
to 78.54 Inches, the Content of the Baſe:
So is 14 Inches the Height,
to 314 Inches, 16 parts of an Inch, for the Content of the Cone in Inches.

Extend the Compaſſes from 3 to 78.54, the Baſe: that extent will reach from 12 the height, to 314 Inches, 16 parts, the Content of the Cone in ſolid Inches.

Example 2. *Let the Diameter of the Baſe be 12 Inches, as before, and the length of the Side be 13 Inches: How many ſolid Inches are there in this Cone?*

1. Extend the Compaſſes from 1 to 5 Inches, half the Diameter of the Baſe; that extent will reach from 5 to 25.
2. Extend the Compaſſes from 1 to 13, the length of the Side: that extent will reach from 13 to 169.
3. From this 169, take the 25 before found, and there remains 144.
4. Upon your Line take half the diſtance between 1 and 144, and you ſhall find it to be 12: which 12 is the height of the Cone: So the height being had, you may find the Content, as in the laſt Example.

III. *Of SPHERICAL BODIES.*

A Spherical Body is ſuch a Body whoſe Superficies in all the parts of it are equally diſtant from the Centre of the Body, as *Globes, Bullets*, &c.

Example 1. *The Circumference of a* Globe *or* Bullet, *being* 28 *Inches*, 28 *parts*, *to find the length of the Diameter*.

As 22,
to 7:
So is 28.28, the Circumference,
to 9 Inches, the Diameter.

Extend the Compaſſes from 22 downwards to 7: The ſame extent will reach from 28.28, the Circumference, downwards to 9 Inches, the length of the *Diameter* of that *Bullet*.

Example 2. *The Diameter of a Spherical Body being given in* 9 *Inches, and its* Circumference *is* 28 *Inches*, 28 *parts*: *How many ſquare Inches are there in the Superficies of that Spherical Body?*

As 1,
is to 9 Inches the Diameter,
So is 28.28 Inches, the Circumference,
to 244.5 Inches, the ſuperficial Content.

Extend the Compaſſes from 1 to 9, the Diameter: The ſame extent will reach from 28.21, the Circumference, to 254 Inches, 5 Parts, the ſuperficial Inches in this ſpherical Body.

Example 3. *The Diameter of a Spherical Body being 9 Inches, how many ſolid Inches are therein contained?*

1. As 1,
is to 9, the Diameter:
So is 9,
to a fourth Number:
And that fourth Number,
to 729, the Cube of the Diameter.

2. As 9, the Diameter,
to 729, its Cube:
So is 11,
to 891 Inches, the ſolid Content of the Spherical Body.

Extend the Compaſſes from 1 to 9, that extent will reach from 9 to 81, and from 81 to 729, the Cube of the Diameter.—— Then extend the Compaſſes from 9, the Diameter, to 729 its Cube: that extent will reach from 11 to 891 Inches, the ſolid Content of the ſpherical Body.

I might here add the manner how to meaſure other kinds of Bodies, both regular and irregular; as *Ellipſes*, *Parabolas*, &c. Alſo of *Priſms*, *Scalenes*, *Cones*, *Spheroides*, &c. But theſe being out of the reach of ordinary Artificers, for whoſe ſakes this Treatiſe was chiefly compoſed, I ſhall here conclude this Treatiſe of the Uſe of the Line of Proportion, with a ſhort Supplement of Gauging of Veſſels.

CHAP.

SUPPLEMENT.

CHAP. XX.

Concerning Gauging of Veſſels by the Line.

BEfore you can meaſure your Veſſel, to find the Content thereof in Gallons or Parts, you muſt find the Content thereof in Inches; and to effect this, you muſt find the Content of two third parts of a Circle, agreeable to the Diameter at the Bung: And one third part of another Circle, agreeable to that of the Diameter at the Heads; theſe two added together, and multiplied by the length of the Veſſel, that Product will be the Content of that Veſſel in Inches.

EXAMPLE.

Let there be a Veſſel whoſe
Dia. at Head, 18
Dia. at Bung, 32
Length is 40
Inches.

And let the Content *thereof, firſt in* Inches, *and then in* Gallons, *be required.*

I. *For the two third parts of the* Circle *at the* Bung.

As 1,
to this univerſal number [5236 :]
So 1024, the Square of the Diameter at the Bung 32,
To 536.166 Inches, which is two third parts of the Content of the Circle at the Bung.

Wherefore, Extend the Compaſſes from 1, to 5236, the ſame extent will reach from 1024 (the ſquare of 32, the Diameter at the Bung) to 536.166 Inches, the Content of 2 third parts of the Circle at the Bung in Inches.

II. *For*

II. *For one third Part of the Circle at the Head.*

As 1,

to this general Number [2618 :]

So is 324, the Square of the Diameter at the Head 18,

o 84.823 Inches, which is one third Part of the Content of the Circle at the Head.

Wherefore, Extend the Compaſ-es from 1 to 2618; the ſame ex-ent will reach from 324 (the Square of 18, the Diameter at the Head) o 84.823 Inches, the Content of one third part of the Diameter at he Head in Inches.

III. *For*

III. *For the Number of ſquare Inches in the Veſſel.*

Add theſe two Numbers—536. 166
and— 84. 823

They make—620. 989
40

Which multiplied by 40, the length of the Veſſel, produceth ——— } 24839. 560

And ſo many ſquare Inches are contained in ſuch a Veſſel, whoſe Diameter at the *Head* is 18 Inches, at the *Bung* 32 Inches, and is 40 Inches long.

IV. *For*

IV. *For the Content in Wine or Ale Gallons.*

Divide this Num- ⎫ 231 for Wine,
er 24839.56, by— ⎭ 282 for Ale,
nd the Quotients ſhall tell you the
umber of Gallons and parts of a
allon.

Wine *Gall. Parts.*

231) 24839.56 (107.52

231

1739

1617
1225

1155
706

693
13

Ale-

```
Ale.                  Gall. Parts.
282) 24839. 56 (88. 08
         ..     ..
       ______ ______
       2256
        2279
       _____ _____
        2256
          2356
        ____ _____
          2256
           100
```

By this Work you may perceive that this Veſſel containeth
- 107 Gallons,5 parts,of Wine meaſure.
- 88 Gallons, 0 parts, of Ale meaſure.

How to multiply and divide by th Line, is taught in the Secon and Third Chapters of this Book and therefore it were needleſ here to repeat it again; But

choſ

choſe rather to do it Arithmetically, for the better Illuſtration, and for the Satisfaction of ſuch as have a Delight in Numbers.

More, concerning Gauging by the Line.

All cloſe Casks or Veſſels, are near to one or other of theſe Forms; viz. *Cylindrical*, *Spheroidical*, *Parabolical*, *Conoidal*, or *Conical*: Every of which, (before it can be Gauged) muſt be reduced to the *Cylindrical Form*: by finding out a *Mean Diameter*, between the *Diameters* of the *Head* and *Bung* of the Veſſel; For the effecting whereof, for moſt Ordinary Casks, the following Direction is a ready

RULE.

RULE.

As 10, is to 7,
So is the Difference of the Diameters of the Head and Bung of the Cask;
To a Number; which added to the Leſſer Diameter of the Cask, ſhall give you the *Mean Diameter* for that Cask.

EXAMPLE.

Let the *Diameter* at the *Head*, be 18 Inches; at the *Bung* 32: Their Difference is 14: And let the *mean Diameter* be required:

Extend the Compaſſes from 10 to 7; the ſame extent will reach (the ſame way) from 14, the Difference, to 9.8 Inches, which added to 18 Inches, the leſſer Diameter, gives the *Mean Diameter* for that Cask, to be 27.8 Inches.

But if the *Cask* be near a *Cylindrical* Form, you may take the Proportion to be; As 10 to 8.

But if near to a *Conical* Form, hen the Proportion may be as 10 o 5.30.

Or, If it be in a *Parabolical* or *Oval* Form, then the Proportion may be taken to be, As 10 to 6.

And for *Casks* whoſe *Staves* well out very much, you may uſe heſe ſeveral Proportions, as you nd them to tend more or leſs *pherical*, viz.

s 10, to $\left\{\begin{matrix}7.3\\7.4\\7.5\end{matrix}\right\}$ ſo the difference

o a fourth Number; which added to the leſſer Diameter, will give you the *Mean Diameter* proper for that *Cask*.

The *Mean Dinmeter* being thu found, the *Area* of the Circle ma be found as in Chapter XIII. Or b this Proportion:

As 10,
Is to the *Mean Diameter* :
So is 78.54, (always)
To the *Area* of the *Circle.*

EXAMPLE.

So the *Mean Diameter* being 27. Inches,

Extend the Compaſſes from 1 to 27.8 (the *Mean Diameter)* th ſame extent will reach (the ſam way) from 78.54 to 218.3, an from thence to 621 ;

And that is the *Area* of that *Cir* *cle* in *Square Inches.* And,

This *Area* being found, the *Co* *tent* of the *Cask* may be found b this Proportion.

A

As 1,
Is to the *Area* of the *Circle* in
Inches;
So is the length of the *Cask* in
Inches,
To the Content thereof in ſolid
Inches.

EXAMPLE.

So, the *Area* of the Circle being 621 Inches; and the length of the Cask 40 Inches.

Extend the Compaſſes from 1 to 621, the *Area* of the *Circle* in Inches, the ſame extent will reach (the ſame way) from 40 (the length of the *Cask* in Inches) to 25000 Inches; for the *Content* of the *Cask* in ſolid Inches.

And this being known, the *Con-ent* in *Wine or Ale Gallons* may be ound by this Proportion.

As 231 (for Wine;) or 282 (fo
Ale;)
Is to 1;
So is the Content of the *Cask* in
ſolid Inches;
To the *Content* in *Gallons*.

EXAMPLE.

So, The *Content* of the *Cask* in ſolid Inches being 25000.

Extend the Compaſſes from 231, (for *Wine*) downwards to 1; th ſame extent will reach (the ſam way) from 25000 (the ſolid Inche in the Cask) to 107.5.

And ſo many *Wine-Gallons* doth that Cask contain.

Or,

Extend the Compaſſes from 282, (for *Ale*) downwards, to 1; the ſame extent will reach the ſame way, from 25000 to 88:
And ſo many *Ale-Gallons* doth the Cask contain.

How to meaſure

Board, Glaſs, Timber, Stone, &c.

BY

A Line of Equal Parts,

Drawn from the Centre of a

Two-Foot Joint-Rule.

ALL Proportions that may be wrought upon a ſtraight Ruler by the Line of Proportion or Numbers, the ſame may be wrought by a Line of Equal Parts, drawn from the Centre of an opening Joint.

And whereas this Line of Equal Parts is numbered from the Centre of the Rule towards the end thereof, by 1, 2, 3, 4, *&c.* to 10; that theſe Figures (as in the other Line) do ſometimes ſignifie themſelves only, ſometimes 10, 20, 30, *&c.* ſometimes 100, 200, 300, *&c.* according to the Quality of the Queſtion propounded.

By this Line you may alſo multiply, divide, work the Rule of Proportion, and perform divers things which the Line of Numbers performeth, and ſome others which that will not; but I ſhall here only ſhew you how Board, Glaſs, Timber, Stone, *&c.* may be thereby meaſured; which I ſhall do in theſe following Propoſitions. And,

I. *For* SUPERFICIAL-MEASURE, *as Board, Glaſs,* &c.

I. *In* INCH-MEASURE,

PROP. 1.

A Plank being 27 Inches broad, and 263 Inches long, how many ſquare Inches are contained therein?

As 1 : to 27 : : So 263 : to 7101.

Take in your Compaſſes the diſtance from the Centre, to 27 (the breadth) upon your Line of equal Parts; with this diſtance ſet one Foot in 10, at the end of the Line, and open the Rule till the other Foot fall in 10, on the other Leg of the Rule.

The Rule thus ſtanding, take with your Compaſſes the diſtance between 263, on one Leg of the Rule, to 263, on n the other Leg; this diſtance will each from the Centre of the Rule o 7101; and ſo many ſquare Inch- s are in that Piece.

PROP. 2.

ſ a Board, or Plank, or piece of Pavement, or of Glaſs, be 20 Inches broad, how much thereof in length ſhall make a Foot ſquare?

As 20 : to 144 : : So 1 : to 7.2.

Take 144, out of your Line of equal parts from the Centre, and ſetting one Foot in 20, open the other Leg till the other Compaſs-point fall in 20 alſo.

The Rule thus ſtanding, take the diſtance between 10 and 10, and that diſtance will reach from the Centre of the Rule to 7 Inches $\frac{2}{10}$ parts of an Inch; and ſo much in length will make a Foot-ſquare.

II. *In* FOOT-*MEASURE*.

PROP. 3.

A Room is 52 Foot broad, and 110.5 Foot long; How many ſquare Foot are there in that Room?

As 52 : to 10 :: So 110.5 : to 57

Take in your Compaſſes 52, the breadth; with this diſtance open the Ruler in 10, and 10; it ſo reſting, take the diſtance between 110.5 and 110.5 on every ſide; that diſtance applied to the Centre of the Rule will reach to 5746, and ſo many ſquare Foot are in that Room.

PROP. 4.

A Plank being 2 Foot, 25 parts broad, how much in length thereof ſhall make a Foot ſquare?

As 2.25, the breadth,
is to 1, or 10:
So is 10,
to 44, the length of a Foot.

Take in your Compaſſes the diſtance from the Centre of your Rule to 1; then ſet one Foot in 2.25, and open the other Leg till the other Compaſs-point fall in 2.25, on the other ſide: The Rule thus ſtanding, take the diſtance between 10 and 10; that diſtance applied from the Centre of the Rule, will reach to 44 parts of a Foot; and ſo much in length will make a Foot.

III. *In YARD-MEASURE.*

PROP. 5.

A Room is hung with Tapeſtry, containing 130 Yards, 25 parts in compaſs, and in depth 5 Yards, 20 parts:

How many Yards of Tapeſtry are in that Room?

As 1,
to 5.20 :
So is 130.25 :
to 677.4.

Take 5.20 in your Compaſſes, and that diſtance put over in 10 and 10 ; the Rule thus ſtanding, take the diſtance between 130.25 and 130.25, on each Leg of the Rule ; that diſtance will reach from the Centre of the Rule to 677 Yards, 4 tenths of a Yard.

II. *For* SOLID-MEASURE, *as Timber, Stone,* &c. *by the Line of equal Parts.*

I. *In*

I. In INCH-MEASURE.

PROP. I.

A Piece of Timber being 30 *Inches broad,* 21 *Inches,* 6 *parts deep, and* 183 *Inches long; How many Foot are contained in that Piece of Timber?*

1. As 1 : to 30 : : So is 21.6 to 641.

Take the diſtance from the Centre, to 30; then ſet one Foot in 10, and open the Rule till the other Compaſs-point fall in 10, on the other Leg of the Rule: Then take the diſtance between 21.6, and 21.6; that diſtance will reach from the Centre of the Rule to 648, the Content of the Baſe or end of the Piece of Timber in Inches: Then,

2. As 1728, the number of Inches in a Foot ſolid,
Is to 648, the Content of the Baſe:
So are 183 Inches, the length,
To 68 Foot, 62 Parts the Content in Feet.

Take in your Compaſſes the diſtance from the Centre to 1728; with this diſtance ſet one Foot in 648, and open the other Leg of the Rule, till the other Point of the Compaſſes fall in 648, on the other Leg; then take in your Compaſſes the diſtance from the Centre, to 183; with this diſtance move both Points of the Compaſſes gently along on both the Lines, on either ſide the Rule, till the Compaſs-points reſt upon one and the ſame Number on either Leg; which you ſhall here find them to do at 68.62 parts; ſo the Piece containeth 68 Foot, and $\frac{62}{100}$ parts of a Foot.

This kind of Work may ſeem troubleſome at firſt; but a little Practice will render it eaſy.

Note, If you take the firſt Number of your Proportion from the Centre of your Rule, you muſt take your third Number thence alſo; and then will your Number ſought be found, as here in this Example. But if you take your firſt Number croſs the Rule, then your third Number muſt be ſo taken alſo, and your Number ſought muſt be taken from the Centre, as thoſe before were.

PROP. 2.

If a Stone be 30 Inches broad, and 21 Inches, 6 parts deep; How much in length of that Stone will make a Foot ſquare?

You muſt firſt find the Content of the Baſe, as is before taught; and it will be 648 Inches: Then,

As 648, the Content of the Baſe, is to 1728, the Inches in a ſolid Foot:
So is 1,
To 2.67 parts.

Take 1728 in your Compaſſes from the Centre: With that extent open the Rule from 648 to 648: The Rule ſo reſting, take the diſtance between 10 and 10; that diſtance applied to the Line from the Centre, ſhall reach to 2 Inches, 67 Parts; and ſo much in length will make a Foot ſolid of that Stone or piece of Timber.

II. *In* FOOT-MEASURE.

PROP. 3.

If a Stone or Piece of Timber be 2 Foot, 50 parts broad, 1 Foot, 80 parts deep, and 15 Foot, 25 parts long; How many ſolid Foot doth that Piece contain?

1. As 1,
   is to 2.50, the breadth;
  So is 1.80, the depth,
   to 4.50, the Content of the
    Baſe in Feet.

Take 2.50 in your Compaſſes from the Centre; with that extent open the Rule in 10 and 10; then take the diſtance between 1.80, and 1.80, that ex-

extent will reach from the Centre of the Rule, to 4 Foot, 50 Parts, the Content of the Baſe.

2. As 1,
 to 4.50, the Baſe:
So 15.25, the length,
 to 68.62, the Content in Feet.

Take 4.50, in your Compaſſes, and thereto open the Rule from 10 to 10, then take the diſtance between 15.25, and 15.25: That diſtance will reach from the Centre of the Rule, to 68 Foot, 62 Parts, the Content of the Stone.

PROP. 4.

The breadth being 2 Foot, 50 parts, the depth 1 Foot, 80 parts; How much in length thereof will make a ſolid Foot?

You may find the Quantity or Content of the Baſe (by the firſt of the laſt Propoſition) to be 4 Foot, 50 Parts: Then,

As 4.50, the Baſe,
 is to 1;
So is 10, or 1 Foot,
 to 222 Parts.

Open the Compaſſes from the Centre to 1: Then ſetting one Foot in 4.50, open the other Leg till the Compaſs-point falleth in 4.50 on the other Leg; then take the diſtance between 10 and 10; and that will reach from the Centre to 222; and ſo many parts of a Foot will make a ſolid Foot of that piece of Stone or Timber.

PROP. 5.

To divide a Right Line into any number of equal Parts, at the firſt opening of the Compaſs.

Let a Line be given to be divided into 6 equal parts: Take the length of the Line given in your Compaſſes: Then becauſe it is to be divided into 6 Parts, put one Foot in 6, on one Leg, and open the other Leg till the other Point fall on 6, on the other Leg. The Rule thus ſtanding, take the diſtance between 1 and 1; that diſtance ſhall divide your given Line into 6 equal Parts. The like for any other Number of Parts whatſoever.

Many other Concluſions may be done by this Line: But I ſhall reſerve them, and divers other Concluſions of the like nature, to a more convenient Place.

The

The USE of the
# Line of Proportion,
IMPROVED;

By which Board, Glaſs, Land, Wainſcot, Hangings, Pavement, Brickwork, Tyling, Plaiſtering, *and any other* Superficial; *As alſo* Stone, Timber, *and other* Solid Meaſure, *may be meaſured without the Uſe of* Pen, Ink, Paper, Compaſſes, *or other* Motion (as ſliding, *or the like*) *whatſoever, by* Inſpection, *only by looking upon the* Line.

The ARGUMENT.

I Am not ignorant how many have written of the Uſe of this Line of Proportion ſince the Invention of

Logarithms, from which Tables this Line is conſtituted and made; as namely; after Mr. *Gunter*'s firſt Contrivance, Mr. *Wingate* ſeconded him, in making divers Lines to ſeveral Radius's, thereby to bring it to extract the Square and Cube-Roots, without doubling or trebling, or dividing the diſtance into two or three Parts. Again Mr. *Will. Oughtred* diſpoſed of theſe Logarithmical Numbers in diverſe concentrick Circles, to be uſed with an opening *Sector* to turn upon the common Centre, thereby to work Proportions; and hath written the Uſes thereof in his Treatiſe, intituled, *The Circles of Proportion.* But nothing here could be done without the help of the Compaſſes.

Again, one *T. Brown*, a Maker of Mathematical Inſtruments, made it in a Serpentine or Spiral Line, compoſed of divers concentrick Circles, therebyto enlarge thedivisions, which was the Contrivance of one Mr. —— *Milbourn*, a *Yorkſhire* Gentleman, who writ thereof, and communicated his Uſes to the aforeſaid *Brown*, who ſince his death attributed it to himſelf; but whoever was the Contriver of it, it is not without inconvenience, for it can in no wiſe be made portable; and beſides (inſtead of Compaſſes) an opening Joint with Thirds muſt be placed to move upon the Centre of the Inſtrument (as in the former Contrivance of Mr. *Oughtred*) without which no Proportion can be wrought.

There is yet a third way contrived, by which this Line is made very ſerviceable and convenient both for uſe and carriage, and is to be uſed without Compaſſes, and is compoſed of two Lines of one length upon either ſide of two Rulers, to ſlide one by the ſide of the other; the uſes whereof in the meaſuring of *Board*, *Glaſs*, *Timber*, *Stone*, &c. and in other parts of

Geometry, *Aſtronomy*, *Fortification*, *Trigonometry*, *Geography*, *Navigation*, *Gauging*, *Dialling*, &c. together with the Uſes of the Lines of Artificial *Sines* and *Tangents*, in the ſame manner contrived, all upon one Ruler, are largely written upon by Mr. *Seth Partridge*, in a Book of his lately publiſhed, entituled, *The Deſcription and Uſe of the Double Scale of Proportion.*

There is yet another way of diſpoſing of this Line of Proportion, by having one Line of the full length of the Ruler, and another Line of the ſame Radius, broken in two parts between 3 and 4; ſo that in working your Compaſſes never go off of the Line. This is one of the beſt Contrivances; but here Compaſſes muſt be uſed.

Theſe are all the Contrivances that I have hitherto ſeen of theſe Lines: That which I here ſpeak of, and will ſhew how to uſe, is only two Lines upon a plainRuler of any length (the larger the better) having the beginning of one Line at the end of the other, the Diviſions of each Line being ſet ſo cloſe together, that if you find any Number upon one of the Lines, you may eaſily ſee what Number ſtands againſt it in the other Line. This is all the Variation: And what this eaſy Contrivance will effect, will appear by the Uſes following.

The Lines are the ſame with the Line of Proportion or Numbers, mentioned and treated of in the former part of this Book: and therefore ow to number upon them is ſhewed n the 1ſt Chapter of this Book, and herefore needs not here again be repeated: Alſo *Multiplication*, *Diviſion*, he *Golden Rule*, *Duplicated* and *Triplicated Proportion*, the *Extraction of Roots*, &c. delivered in the ſecond, hird, fourth, fifth Chapters, *&c.* as lſo in meaſuring of *Superficies* and

H *Solids*,

Solids, and the Menſuration of othe Figures treated of through th whole Book, theſe Lines thus diſpoſed will effect with Compaſſes: Bu ſome of thoſe Uſes which they wi effect in meaſuring without the hel of Compaſſes, I will here ſhew.

CAUTION.

What Meaſure ſoever you meaſure by, let the Integer or Gran Meaſure be divided into 10 or 10 parts (it matters not of what lengt your Lines of Proportion be, for t them all Meaſures are alike.) Thu if you meaſure any thing by th Foot, let your Foot be divided int 100 parts: If by the Yard, divid your Yard into 100 parts: If by th Ell, divide that into 100 parts. S likewiſe if by the Perch, Rod, *&* or by what Meaſure ſoever, let th Grand Meaſure (as I ſaid before) b divided into 100 parts.

CHA

CHAP. I.

Of SUPERFICIAL MEASURE.

BY *Superficial Meaſure* is meant all kinds of flat Meaſure, ſuch as is *Board*, *Glaſs*, *Pavement*, *Hangings*, *Plaiſtering*, *Tyling*, *Land-meaſure*, &c. And theſe ſeveral Things are meaſured by diſtinct Meaſures, as ſome by the *Foot*, others by the *Yard*, others again by the *Ell*, ſome by the *Rod*, and ſome by the *Square*: Of all which I ſhall give Examples: And,

I. *Of* FOOT-MEASURE.

Example 1. *If a Board be* 1 *Foot*, 64 *parts broad, how much in length of that Board will make a Foot ſquare?*

Look upon one of your Lines (i matters not which) for 1 Foot, 6 parts, and right againſt it on th other line, you ſhall find 61; and ſ many parts of a Foot, will make Foot ſquare of that Board.

Example 2. *A Plank is 3 Foot, 5 parts broad, How much thereof i length will make a Foot?*

Find 3 Foot, 50 parts upon on Line, and right againſt it on th other Line, you ſhall find 28 part and $\frac{4}{7}$, or ſomething more than hal a part; and ſo much in length wi make a Superficial Foot.

Example 3. *If a Board be 75 par of a Foot broad, how much there in length ſhall make a Foot ſquare*

Look upon one of your Lines for 75, and right againſt it you ſhall ind 1 Foot, 33 parts, and ſo much n length makes a ſquare Foot.

Note, If the breadth of any thing given be more than one Foot, then the length of a Foot ſquare muſt be leſs than a Foot, as in the two firſt Examples it was: But if the breadth given be leſs than a Foot (as in this laſt Example) then the length of a Foot ſquare muſt be more than a Foot.

xample 4. *A Pane of Glaſs is 35 parts broad; how much in length makes a Foot?*

Find 35 in one Line, againſt it ou ſhall find 2 Foot, $85\frac{4}{7}$ parts; and o much in length makes a ſquare oot.

Example 5. *A Pane of Glaſs is 3 Foot broad, How much in length makes a Foot?*

Find 3 Foot in one Line, againſt it in the other you ſhall find 33 parts; and ſo much in length makes a Foot ſquare.

Example 6. *If a Piece of Glaſs be 1 Foot, 98 parts broad; How much in length will make a Foot?*

Look 1 Foot, 98 parts in one Line, and againſt it in the other you will find 5 Foot and half a part; and ſo much in length makes a Foot.

II. *Of YARD-MEASURE.*

Example 1. *A Gallery is Wainſcoted 2 Yards, 56 parts deep; how much of that length will make a Yard ſquare?*

Seek 2 Yards, 56 parts in one Line, and againſt it on the other you ſhall find 39 parts and ſomewhat more; and ſo many parts of a Yard will make a Yard ſquare.

Example 2. *A Room is Wainſcoted 1 Yard, 13 parts high; How much in length thereof will make a Yard ſquare?*

Look one Yard, 13 parts in one Line, againſt it in the other you will find 88 parts and above half a part; and ſo much in length makes a Yard ſquare.

Example 3. *If the Frieze about a Room be 62 parts of a yard broad; How much in length thereof will make a Yard ſquare?*

Find 62 parts in one of your Lines, and againſt it in the other, you ſhall find 1 Yard, 61 parts, and ſomewhat more ; and ſo much in length makes a Yard ſquare.

Example 4. *There is a Gallery paved with Marble, being 5 Yards, 70 parts broad ; How much of that in length will make a Yard ſquare ?*

Seek 5 Yards, 70 parts in one Line, and againſt it in the other, you ſhall find 17 parts and an half ; and ſo much in length of that Pavement will make a Yard ſquare.

Example 5. *A Parlour being 7 Yards, 29 parts broad, hath a Cieling of Fret-work plaiſtered ; How much of that breadth will make a Yard ſquare ?*

Find 7 Yards, 29 parts, in one of your Lines, and right againſt it in the other Line you ſhall find 13 parts, and $\frac{7}{10}$, which is above half a part: So that 13 parts and a little more than half a part will make a Yard ſquare of that Cieling.

Example 6. *A Plaiſterer hath Rendred the inſide of a Wall containing 2 Yards, 36 parts in height; how much of that will make a Yard ſquare?*

Find 2 Yards, 36 parts in one of your Lines, and right againſt it, on the other you ſhall find 42 parts $\frac{3}{10}$ of a part, that is, ſomething more than 1 third part of a part; and ſo much in length makes a Yard ſquare.

III. *Of MEASURE by the* ELL.

Example 1. *There is a Room hung with Tapeſtry, which is* 4 *Ells,* 25 *parts high ; How much Tapeſtry in length will make an Ell ſquare?*

Note, Here by Ells we underſtand *Flemiſh* Ells (for by that Meaſure are Hangings ſold;) which Ell contains three quarters of our Yard ; that is, 75 parts of our Yard. So that if an Upholſterer have his *Flemiſh* Ell divided into 100 parts, he may meaſure his Hangings as in the Examples following is ſhewed.

Here becauſe the Hangings are 4 Ells, 25 parts deep, Look for 4 Ells, 25 parts in one of your Lines, right againſt which in the other you ſhall find 23 parts and a half, and ſo many parts of his Ell will make a *Flemiſh* Ell ſquare.

Example 2. *The Embroidery of a Pair of Vallens about a Bed is 28 parts of a Flemiſh Ell deep; How much of that Embroidery in length will make a Flemiſh Ell ſquare?*

Look for 28 parts in one of your Lines, and againſt it in the other Line you ſhall find 3 Ells, and 57 parts of an Ell; and ſo much in length will make an Ell ſquare.

Example 3. *A Gallery being 3 Ells 98 parts deep, is hung with Arras; How much of that depth will make an Ell ſquare?*

Seek 3 Ells, 98 parts in one Line, againſt which in the other you ſhall find 25 parts and $\frac{1}{8}$ of a part; and ſo much in length will make an Ell ſquare.

IV. Of *MEASURE by the ROD.*

Example 1. *There is a Brick-Wall, which is 75 parts of a Rod high; How much in length of that Wall will make a Rod ſquare?*

Note, That all Wall-work is by the Brick-layers meaſured by the Rod, which contains 16 Foot and an half in length: Wherefore, let his Rod, being 16 Foot and an half in length, be divided into 100 equal parts, and then let him work as followeth.

The Wall being 75 parts of a Rod high, Look for 75 parts in one Line, and in the other Line right againſt 75, you ſhall find one Rod, 33 parts of a Rod; and ſo much of that Wall in length is contained in a ſquare Rod.

Example 2. *A Carpenter hath Railed and Paled in a Garden with Pales 52 parts of a Rod high; How much of that Paling ſhall make a Rod ſquare?*

Seek 52 parts in one Line, againſt it in the other Line you ſhall find 1 Rod, 92 parts; and ſo much in length will make a ſquare Rod of that Paling.

Example 3. *A Brick-layer hath made a Sewer to carry Water; the Bottom, Sides and Arch together contain 1 Rod, 64 parts; How much of that Drein or Sewer makes a ſquare Rod?*

Find 1 Rod, 64 parts, in one of your Lines, and right againſt that Number you ſhall find in the other Line almoſt 61 parts; and ſo many parts of a Rod in length will make a Rod ſquare.

And here note, That though I have here put theſe two laſt Examples, that Paling is not meaſured by the Square Rod, but (let the height thereof be what it will) it is meaſured by the Rod in length: In like manner is Hedging, Ditching, and many other things that are meaſured by the Rod.

Example 4. *If a piece of Land be 2 Rod, 31 parts broad, how much in length thereof ſhall make a Rod ſquare?*

Seek 2 Rods, 31 parts upon one of your Lines, and over-againſt it upon the other Line you ſhall find 42 parts and about $\frac{2}{3}$ of a part; and ſo much in length makes a ſquare Rod.

Example 5. *A Piece of Land being 80 parts of a Rod broad: How*

How much thereof in length ſhall make a Rod ſquare?

Look for 80 parts in one Line, and in the other line oppoſite thereunto you ſhall find 1 Rod, 23 parts, and ſo much in length makes a Rod ſquare.

V. *Of MEASURING by the SQUARE.*

There are two things principally which are meaſured by the Square, and they are Tyling of Houſes, and Flooring of Rooms; and in this reckoning they account a Square to be 10 Foot every way: So that for this kind of Meaſure divide a Line or Rod of 10 Foot long into 100 parts, and it is fit for the purpoſe.

Example 1. *A Barn, the breadth of the Tyling whereof on both ſides is* 1 *Square,* 30 *parts; How much in* *in length of that Tyling will make a Square?*

Find 1 Square, 30 parts, upon one of your Lines, and right againſt it on the other line you ſhall find 77 parts almoſt; and ſo much in length of that Tyling will make a Square.

Example 2. *The Tyling of a Houſe, is 76 parts of a Square broad; How much in length thereof will make a Square?*

Seek 76 parts in one Line, and againſt it in the other you ſhall find 1 Square, 31 parts and a half almoſt: And ſo much in length will make a ſquare Square, that is, 10 Foot every way, in all 100 Foot.

CHAP. II.

Of SOLID MEASURE.

BY *Solid Meaſure* is meant ſuch *Meaſure* as hath *Length*, *Breadth* and *Thickneſs*; ſuch as *Timber*, *Stone*, or the like. But before Timber or Stone can be meaſured, you muſt find the Content of the Square of the Baſe thereof, which is taught by the Problem at the end of the Tenth Chapter: But that being performed by Compaſſes, I will here ſhew how it may be (by theſe Lines thus diſpoſed) performed without; and that ſhall be my firſt Propoſition or Example.

Example 1. *Let a Piece of Timber or Stone, be 80 Parts of a Foot deep,*

deep, and 3 Foot, 75 parts broad; How much in length of that Piece will make a Foot ſquare?

Here (by any of the former Rules of Superficial Meaſure) find at 80 parts broad, how much in length will make a Foot, which you will find to be 1 Foot, 25 parts: For,

If you find 80 parts, the depth of the Piece in one line, againſt it in the other you ſhall find 1 Foot, 25 parts. Take 1 Foot 25 parts of your Foot Rule, and meaſure it along the breadth of the Piece, which is 3 Foot, 75 parts, and ſee how often it is contained therein, which you ſhall find to be three times: wherefore, you may conclude that the Square of the Baſe of that Piece of Timber whoſe depth is 80 parts, and whoſe breadth is 3 Foot, 75 parts, is juſt 3 Foot.

Now the Square of the Baſe of the Piece being thus obtained, you may find the length of a Foot ſolid thereof in this manner.

Example 2. *Let the Square of the Baſe of a piece of Timber or Stone be 3 Foot; How much in the length of that Piece will make a Foot ſolid?*

Look for 3 Foot in one of your lines, and in the other right againſt it you ſhall find 33 parts and $\frac{1}{3}$ part of a part; and ſo much in length will make a Foot ſolid.

Example 3. *Let a Piece of Stone or Timber be 2 Foot, 50 parts broad, and 50 parts deep; how much of that Stone in length ſhall make a ſolid Foot?*

By any of the ways before preſcribed, you ſhall find that the depth of your Stone being 50 parts, it will require 2 Foot in length thereof to make a Foot ſquare: Wherefore, meaſure how often you can find 2 Foot in the breadth of your Solid, which you can find only once, and 50 parts more, which is one quarter of two Foot: Wherefore, the Square of this Solid contains 1 Foot, 25 Parts. Wherefore, Look in one of your Lines for 1 Foot, 25 Parts, and right againſt it you ſhall find 80 Parts; and ſo much in length will make a Foot ſolid.

Example 4: *The Square of the Baſe of any Regular Solid being given, together with the length of the ſame Solid; To find how many ſolid Feet are contained in the ſame.*

Let the forementioned Solid ſerve for this Example alſo, whoſe length was 32 Foot: We found that the

Square of the Baſe was 1 Foot, 25 parts, and that 80 parts in length would make one ſolid Foot: Wherefore, take 80 parts of your Rule, and run it along the Piece as often as you can, which you ſhall find to be 40. So that in this Piece of Timber there is 40 Foot.

I might add many more Examples this kind, and ſome to other purpoſes; but theſe are ſufficient for the Purpoſe intended. And ſo I ſhall conclude this Treatiſe, leaving the farther Practice thereof to your ſelf: For,

Uſus optimus Magiſter.

CHAP. III.

Of CIRCULAR MEASURE.

By having either the Circumferenc or Diameter of any Circle given thereby to find the Side of a Square equal to the ſame Circle or the Side of a Square that ma be inſcribed within the ſame Circle.

IN the Thirteenth Chapter of thi Book you have ſix Examples, b having the Circumference or Diameter of any Circle given, thereby t find the Side of a Square equal to th Superficial Content, &c. But I hav ſeen upon ſome Two-foot Rules Lines to effect this thing, by only opening the Compaſſes to the diſtanc given upon one Line, and applyin th the ſame to ſome of the other Scales: One of thoſe Scales is noted at the end thereof with *C*, ſignifying the Circumference of any Circle: The other with *D*, ſignifying the Diameter: The other with *S.E*, ſignifying Square Equal to the Circle: The other with *S.W*, ſignifying Square Within.

Example. So that if I ſhould have given you the Diameter of a Circle, being 15 Inches; out of the line noted with *D*, take 15 Inches; apply that diſtance to the line noted with *C*, it will reach to 47 Inches and $\frac{13}{100}$ parts of an Inch: And ſo much is the Circumference of that Circle.

Again, the Diameter being 15 Inches, as before, take that Diſtance out of the line *D*, and it will reach upon the line *S.E*, to 13 Inches $\frac{29}{100}$ parts: And that ſhall be the ſide of a Square equal to the Circle whoſe Diameter is 15 Inches.

Again, the Diameter being 15 Inches, if you take that diſtance out of the Line noted with *D*, it will reach upon the Line *S. W*, to 10 Inches $\frac{60}{100}$ parts of an Inch: And that is the length of the Side of the greateſt Square that can be drawn within that Circle whoſe Diameter is 15 Inches.

The like may be done, if the Circumference were given, by taking the Circumference thereof out of the Line noted with *C*, and applying it to the other Scales.

This I thought convenient to add here, becauſe ſometimes theſe Lines are put upon Two-foot Rules.

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